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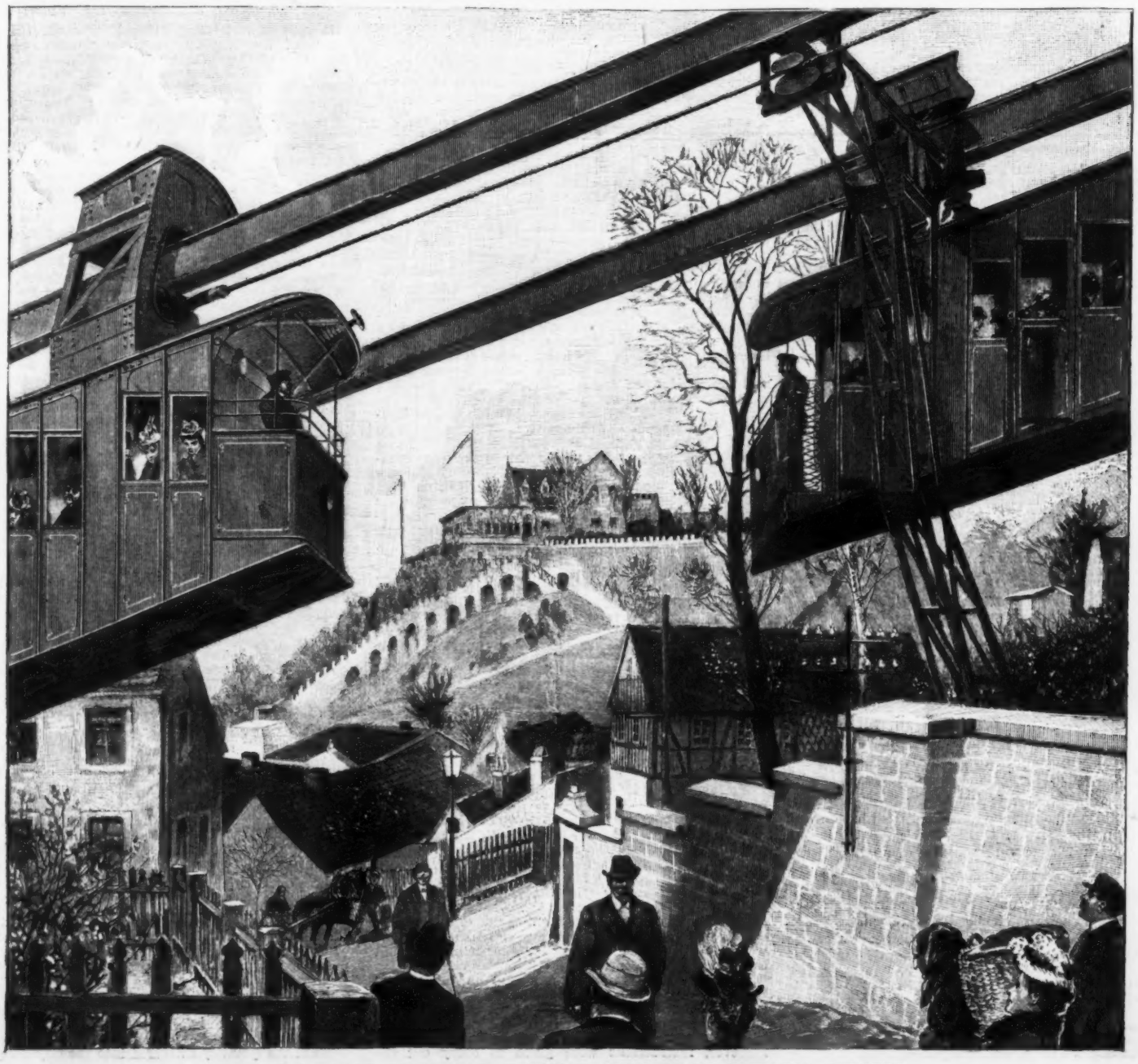
THE NEW SUSPENDED RAILWAY OF LOSCHWITZ, NEAR DRESDEN.



THE LOSCHWITZ SUSPENDED RAILWAY SEEN FROM VICTORIA STRASSE.

THE LOSCHWITZ SUSPENDED RAILWAY.

The suspended railway which is to take the place of the cable-road on the heights of Loschwitz, near Dresden, will soon be opened to the public, according to the Illustrirte Zeitung.

The new road is about 1,000 feet in length and is built on thirty-two piers. From the lower station, situated not far from Loschwitz Church, the road runs along Victoriastrasse leading to Roschwitz Plateau, and thence up to Loschwitz Plateau. The two stations are not without their good architectural points. The lower station is built in the Flemish Renaissance style; the upper, with four queer towers, is more modern in appearance. The upper station serves both as a terminus and as a power house. The rolling stock consists of four cars, each of which has a capacity of fifty.

The Loschwitz railway is not the only road of its kind which has been built. Between Bremen and Eberfeld a road has been in operation which is built on the same principle, and which has been fully described in the Scientific American.

THE ANCIENT HISTORY OF WATER ENGINEERING.*

By James Mansergh, President Inst.C.E.

Until the advent of modern electrical engineering I have hitherto looked upon the work of a hydraulic engineer as the most interesting, as it probably is the most ancient, branch of our practice. The railway engineer began his business seriously only a few years before I was born, and the electrical engineer is a creature but of yesterday; while one of my predecessors built a dam of hewn stone at Kosheish, to divert the course of the Nile from the spot upon which Meua desired to build Memphis, nearly 5800 years ago.

In Egypt also a canal was made by order of Usertesen III., by which he sailed southward to crush Ethiopia 2660 years B.C.

In Babylonia, 2350 B.C., Siniddinam, the King of Larsa, enlarged the canal—still more ancient work—on which Larsa was situated, while Rimsin, King of Elam, provided an outlet for the Tigris (River of the Gods) into the Persian Gulf about the same time.

Khammurabi, the King of Babylon, about 2320 B.C., having witnessed the ravages of floods in the Lower Tigris, organized a system of improvement in the complicated network of ditches and channels which intersected the territory belonging to the great cities between Babylon and the sea, with gratifying results.

In India efforts were made in very early times to preserve and utilize the rains and rivers, and in Beluchistan the great Cyclopean dams of stone known as the Ghorbasta were erected, it is believed, about 1800 B.C., or 3700 years ago.

In Egypt, irrigation works can be traced back to a very remote period. In that comparatively level country an extensive system of artificial ponds, reservoirs or lakes, with a network of distributing canals, was in existence at least as early as the time of Sesostris, otherwise Rameses II., about 1388-1322 B.C.

If the art of irrigation was taught to the ancient Egyptians by the natural overflowing of the Nile, it is probable that Egypt in her turn afforded an example to Assyria and Babylon, to Carthage and Phœnicia, and also to Greece and Italy.

In Persia there is evidence that the hydraulic engineer had carried out irrigation works from 600 B.C. to 700 B.C.

In Greece, Athens was supplied about 520 B.C. with water from an ancient spring called Callirhöe, flowing from the foot of a broad ridge of rocks which crosses the bed of the Iliasus.

In Ceylon it is believed the first tank for irrigation purposes was built by Pandinousa, the second of the Hindu kings, in the neighborhood of his capital, Anuradhapoore, about 504 B.C.

In India it appears, on the testimony of the Greek writer Megasthenes, who lived about 300 B.C., that irrigation was certainly practised before his time.

Coming down into the Christian era, the aqueduct of Merida in Spain was erected about 10 A.D., that of Segovia about 105 A.D. and the new water supply for Olympia was introduced by Herodus Atticas A.D. 157.

In the early seventies I had a commission to examine and report upon the Claudian aqueduct, by which water was supplied to Naples 1800 or 1900 years ago from the Orciuoli springs in the Sabato Valley, between Serino and Avellino. At the time of my visit the river bed was practically dry from Orciuoli upward toward Serino, and it was most interesting to see how the welling out of the ground of these magnificent springs went to produce in a few chains a stream of probably 15,000,000 to 20,000,000 gallons a day. I found the remains of the Claudian aqueduct in several places both below and above ground.

I had great difficulty in obtaining permission to examine the former, and it was only through the authority of the local Syndic, under pressure from a member of the Italian Parliament, who accompanied me, that I obtained a guide to one of the shafts. This man protested piteously against the removal of the shaft covering, and crossed himself vigorously when I took steps to ascertain the depth to the conduit.

I got out a scheme to utilize the springs on modern lines and made an estimate of the cost, but nothing further came of it at the time. Some ten years later, however, the work was taken in hand, and now Naples is supplied from the source utilized in the time of Claudius.

ANCIENT ROMAN WATER WORKS.

In refreshing my memory about early water works, I have been pleased to find the history of nine of the aqueducts of Rome, as told by Sextus Julius Frontinus, water commissioner of that city, in the second half of the first century of the Christian era, and I propose to go into some detail about them, at the risk of retelling to some of you a story that you are already well acquainted with.

This work of Frontinus has become accessible to English readers through the enterprise of Mr. Clemens Herschel, an American engineer, who has published a photographic reproduction of the original Latin manuscript preserved in the monastery of Montecassino, about halfway between Rome and Naples, and its reprint in modern Latin; also a translation into English, and some explanatory chapters.

The sentiment embodied in the opening paragraphs of Frontinus's first book is so admirable, and so equally applicable to the twentieth as to the first century, that I make no apology for transcribing it literally. He says: "Inasmuch as every office conferred by the Emperor demands special attention, and inasmuch as I am moved not only to devote diligence, but even love, to any matter confided to my care, be it on account of inborn zeal or by reason of faithfulness in office; and inasmuch as Nerva Augustus, an Emperor of whom it is difficult to say whether he devotes more love or more diligence to the common weal, has now conferred upon me the duties of Water Commissioner; duties contributing partly to the convenience, partly to the health, even to the safety, of the city, and from olden times exercised by the most distinguished citizens. I therefore consider it to be the first and most important thing to be done, as has always been one of my fundamental principles in other affairs, to learn thoroughly what it is that I have undertaken. There is, indeed, no better foundation for any business, nor can it in any other way be determined what is to be done and what omitted; nor is there for a fair-minded man so debasing a course as to perform the duties of an office entrusted to him according to the direction of subordinates; a course, however, which must be followed whenever an experienced official takes refuge in the practical knowledge of his assistants, whose services, though necessary for rendering help, should nevertheless be only a sort of hand and tool of the principal in charge. It is for this reason that I have set down in this commentary all that I could gather as bearing on the subject-matter, after having arranged it and codified it in accordance with my habits, so that I might consult it as a guide in the duties of this."

I think you will agree with me that this is admirably put by the fine old Roman gentleman who did his honest and conscientious work as *Curator Aquarum* over 1800 years ago, and that his words are worthy to be recorded in our "Transactions."

From the foundation of Rome in 754 B.C., for 441 years—that is, to 313 B.C.—the citizens were content with using water which they drew from the Tiber, or from wells or from springs, but in that year the Appian water was brought into the city by the Censor Appius Claudius Crassus, who also had charge of the construction of the Appian Way from Porta Capina to the city of Capua. He had for his colleague Plautius, who received the name of Venox (the Searcher of Springs) on account of his search for the springs of this water.

Appius appears, however, to have been the smarter of the two, for while Plautius was induced to resign his office before the expiration of the normal term, Appius contrived to extend his until he had not only completed the aqueduct, but also the highway. Hence he enjoyed the honor of giving his name to Rome's first aqueduct. The water which this conduit brought into the city was derived from springs situated about half a mile along a cross-road leaving the Prenestine Way between the seventh and eighth milestones from Rome.

Beginning at the springs and entering the city at the Porta Trigemina, its length was about 10.6 miles, of which all but 300 feet was laid underground, the remainder being on a masonry substructure above ground or on arches. Its cross section was 5 feet high by 2.5 feet wide, and probably rectangular. It delivered water at a comparatively low level, i. e., about 55 feet above the sea in the city, but its height at the springs Frontinus does not state, nor have I been able to ascertain it from any other source.

The second of Rome's aqueducts was a more ambitious, much longer, and consequently much costlier, undertaking than the Appia.

In the year 273 B.C. the censor Manius Curius Dentatus contracted to have the waters of the river Anio rising in the Apennines brought into the city for a sum realized by the sale of the spoils taken from Pyrrhus. Two years later Curius and Fulvius Flaccus were elected water commissioners, but Curius died five days after, and Fluvius finished the work. This aqueduct, *Anio Vetus*, had its intake from the river upstream from the Tiber at the twentieth milestone outside the Barranean Gate, and early on its course a branch was taken off to supply Tivoli. Above the point of abstraction the river Anio has a length of about 21 miles, and a drainage area approximating to 151 square miles. There is no record showing that any subsiding reservoir was constructed at the intake, but it would ill become us modern engineers to criticise our predecessors of 2,000 years ago in this respect, for it is only a short time since there was little more than a pretense of such reservoirs on the works of the London companies, and at Philadelphia the water is to this day taken direct from the tidal rivers Schuylkill and Delaware into the service reservoirs and distributing mains of the city.

The Anio Vetus had a length of 40.7 miles, mainly underground, there being only 1,100 feet above ground on a masonry substructure, and apparently no arches. The cross-section of the conduit was 8 feet high by 3.7 feet wide, but we have no authentic record of the fall between the two termini, nor how that fall was distributed throughout the length.

In 145 B. C., when the Appia and Old Anio had become leaky by reason of age, and water had been diverted from them by unlawful takings, the Senate commissioned Marcius—who at that time administered the law as Prætor—to restore these aqueducts to usefulness, and to protect them, and because the growth of the city seemed to demand an increased supply, he was also empowered to investigate whether he could bring other additional waters into the city.

He seems to have made a report on the subject recommending a source near to the thirty-eighth milestone on the Sublascensian Way, "where numberless springs gush forth from caves in the rocks immovable like unto a pool, and of a deep green hue." Before, however, instructions were given to carry out the work, a discussion arose among the Council of Ten who, consulting the Sibylline Books for another purpose, found that it was not right for the Marcian waters—and still less for those of the Anio—to be brought to the Capitol. It was a little late in the day to make this latter discovery, because the Anio water had been used in the city at that date for over 160 years. The matter was then discussed in the Senate, and revived three years later, but ultimately the popularity of Marcius Rex carried the day, and it was decided to utilize these beautiful springs.

Fenestella says that 180 million "sestertii" were appropriated for the works of the Marcian Aqueduct—equal, if the basis of calculation is correct, to over £1,600,000. This sounds like a big estimate for such a work in those days, and possibly there is some mistake. Its length was about 58.4 miles, of which 51.3 were below ground—what we should now call cut-and-cover work contouring the hillsides—0.5 mile on a substructure of masonry above ground, and 6.6 miles on arches. It would have been intensely interesting to have seen a longitudinal section of this or any other of the ancient aqueducts, and the instruments with which the engineers did their leveling, so as to maintain the gradients of their conduits. The cross-section of Marcia was 5.7 feet in height and 3.5 feet in width, and it delivered water in Rome at an elevation of 201 feet above sea-level.

Thirty years ago the use of the Marcian spring water was resumed in Rome under a concession granted to an English company by Pope Pius IX., and the name given to the modern aqueduct is "Acqua Pia."

The engineer who has the honor of effecting this revival is Colonel Bernard Blumenstihl, who, in his little book entitled "Brevi Notizie sull Acqua Pia (Antica Marcia), 1872," gives a full account of his search for and discovery of the ancient Marcian springs. He says that these springs are now called the second and third "Serena" situated on the north side of the Anio, a short distance down stream from Agosta. He has found the ancient masonry conduit leading the water from the springs toward Rome.

In the year 127 B. C., that is eighteen years after the Marcia, the Tepula aqueduct was constructed by the Censors Servilius Coepio and Cassius Longinus. The source of the water utilized by this aqueduct was certain volcanic springs situated nearly two miles to the right of the Latin Way as one comes from Rome, and near the tenth milestone, on the slopes of Mount Albani. This is about half-way between Frascati and Rocca di Papa. It will be noticed that the first and third Roman aqueducts received the names of the men chiefly responsible for their construction, Appius and Marcius.

In this case the name Tepula was adopted on account of the slightly warm or tepid character of the water of the springs (63 deg. F.), which are now called Sorgenti dell' Acqua Preziosa, on account possibly of their possessing some curative properties. Up to the time of the building of the Tepula conduit, these structures had been made principally of dimension masonry, but in this one concrete was almost exclusively used. What the exact length of Tepula was I cannot make out, but it was probably a mile or two less than Julia, which was made next, and of its whole length nearly half must have been on arches. Its cross-section was 3.3 feet high by 2.7 feet wide, and it delivered water to the city a few feet higher than Marcia, or probably about 208 feet or 210 feet above sea-level.

In the year 35 B. C. Agrippa, when he was Aedile, appropriated certain springs in the neighborhood of the Tepula, but further up toward Roca di Papa, these springs—the Julia—having three times the volume of Tepula, and yielding water of 13 deg. lower temperature.

The Tepula was taken into the city for 93 years, after which time, viz., in 33 B. C., Agrippa brought the water by a branch conduit from the Julia springs into the Tepula Aqueduct, and thus produced a mixture which, having regard to relative volumes, had a temperature of probably 53 deg. or 54 deg. This water flowed in one and the same channel for four miles, and was then divided into two and went on by the old Tepula and the new Julia conduits, and entered the city near the present Porta Maggiore, Tepula being in the middle and sandwiched vertically between Marcia below and Julia above.

The Julia conduit was 4.6 feet high and 2.3 feet wide; its total length was 14.6 miles, of which 0.5 mile was above ground on a concrete base, 6.13 miles on arches, and the rest below ground.

In 33 B. C. Agrippa rebuilt the nearly ruined aqueducts of Appia (280 years old), Anio (240 years old), and Marcia (112 years old), and furnished the city with a large number of ornamental fountains. He also, thirteen years later, took in hand the utilization of other springs found on the estate of Lucullus in the valley of the Anio, and only a short distance upstream from the Appia springs.

The story goes that these springs were pointed out to the soldiers who were searching for water by a young girl of the district, and that, on opening out the ground all round, a great quantity was discovered, justifying the making of still another aqueduct, to which was very appropriately given the name of Virgo. A little temple was erected near the intake, and in it a picture was placed representing the incident. The source was on the Callatian Way near the eighth milestone. The cross-section of the conduit was 6.6 feet high by 1.6 feet wide, and its length 13.35 miles, of which 12.18 miles were underground, 0.51 mile on a masonry base, and 0.66 mile on arches. This was a low-level supply delivering the water into Rome only 67 feet above sea-level.

It would appear from the foregoing records that in the time of Agrippa, shortly before the commencement of the Christian era, the city of Rome must have been magnificently furnished with water, for Agrippa had restored Appia, Anio, Vetus, and Marcia, and Tepula was probably in good working condition. He had also constructed Julia and Virgo, so that the whole six aqueducts—five carrying spring water and one that of the River Anio—were all contributing to the supply.

What the quantity delivered into the city daily actu-

* Abstract from the Presidential Address to the Institution of Civil Engineers, November 6, 1900. From The Engineering Times.

ally was must necessarily be a matter of the vaguest conjecture; for, first, we have no data as to the yield of each source; second, we know nothing of the ruling fall in any of the aqueducts, so cannot estimate their discharging capacity; third, we have no information as to the quantity legitimately disposed of en route; fourth, we cannot tell how much was surreptitiously abstracted by unauthorized or "winked at" tappings of the conduits; and fifth, we do not know the amount of leakage through structural defects.

Of the seventh aqueduct bringing water to Rome, known as the Alsietina, our friend Frontinus has nothing but adverse criticism, and he wonders how so exceedingly cautious a ruler as Augustus could have taken the trouble to supply a water which was so unwholesome that it could not be used at all for domestic purposes. The only excuses he can make for the projector were, first, that he had undertaken to establish a "Naumachia" (a sort of glorified Earl's Court marine circus), and wanted to avoid wasting good water to fill it; and, second, that this water, coming in as it did on the opposite side of the Tiber to that where all the other aqueducts delivered, could be used at times when no water could be got from that side, owing to repairs of the bridges.

The source of this supply was the Alsietinian Lake, near a cross-road, 6.16 miles from the Claudian Way at the fourteenth milestone. The aqueduct was 21 miles in length, of which 19.71 miles were underground, and 0.34 mile on arches. The water was delivered in the city at only 55 feet above sea-level, so that there was a fall of 625 feet in the aqueduct, for the altitude of Lake Alsientina is 680 feet.

Augustus, however, did a small but useful work by the building of a conduit about three-quarters of a mile in length, bringing in water to supplement the Marcian springs in times of drought, and to this conduit he gave the name Augusta. After this, and because the seven aqueducts were not sufficient to meet either the public needs or the demands of private luxury, Tiberius began, in the second year of his reign, A. D. 36, the construction of two aqueducts, one taking water from the Cerulian and Curtian springs, and the other from the River Anio. These works were completed in the most splendid manner by Claudius fourteen years later; that is, in A. D. 50, the former being named after himself, Claudia, and the latter Anio Novus.

The Claudian springs rise about 500 yards to the left of the Sublascensian Way, near the thirty-eighth milestone, and in addition to the two above mentioned, the water from a very pure spring called Albudinum was taken into the Claudian conduit. This aqueduct had a cross-section 6.6 feet high and 3.3 feet wide, and its length was 43.9 miles, of which 34.3 miles were underground, 0.58 mile above ground on masonry base, and 9.06 miles upon arches. The water was delivered at the Porta Maggiore at 230 feet above sea-level.

Claudia followed very nearly the course of Marcia, but some thirty-six years after completion it was shortened by driving a tunnel about three miles long under Mount Affiano, not far from S. Gregorio. This tunnel was undertaken by a contractor named Pasquedius Festus, and must have been a difficult work, when even black powder for blasting purposes was unknown.

Three hundred and fifty-nine years after the Anio Vetus was built—that is, in A. D. 86—the River Anio was again tapped at a point near the forty-second milestone on the Sublascensian Way in the Simbruinum. This intake is five miles above that of the old Anio, and consequently at a higher level, and the drainage area above it is about 87 square miles. Here the river runs through rich cultivated lands, and has loose banks, so that the water was normally muddy and discolored (like the Medway about Tonbridge), and worse, of course, after rain. To take out this suspended matter, a settling reservoir was constructed below the intake, but this was evidently of insufficient capacity, and being unaided by any process of filtration, the water was delivered in a discolored condition into the city in times of rain.

The Herculaneum brook, which has its source also near the Sublascensian Way at the thirty-eighth milestone, opposite the springs of Claudia, was tapped and taken into the Anio Novus. This was a clear stream, but its contribution was not of sufficient volume materially to improve the quality or appearance of the Anio water. The cross-section of this aqueduct was 9 feet high by 3.3 feet wide, its length was 55.6 miles, of which 46.7 was below ground, and in its upper reaches a length of 2.18 miles was on masonry foundations above ground or arches, and nearer the city 0.58 of a mile on masonry and 6.14 miles upon arches, some of these being the highest of all the aqueducts, rising as they do to 109 feet above the ground.

After Frontinus's time two other aqueducts were made, viz., the "Trajana," taking its water from springs near Lake Bracciano, northwest of Rome, and the Alexandrina (also called Hadriana), built by Severus Alexander A. D. 226, and utilizing springs near the Via Prenestina. All these old aqueduct waters were very hard. There do not appear to have been at the city termini of the aqueducts any large service reservoirs containing from one day to six days' supply of the quantity dischargeable by each aqueduct, as would be the case nowadays, but merely small tanks (piscinæ), and from which pipes of lead or earthenware fortified with concrete were taken off to provide water to separate private consumers, baths, fountains, etc. All the aqueducts bringing in water from the east appear to have crossed the northeast side of the city toward the Diocletian baths; that is, to the neighborhood of the present Central Railway Station.

We have been accustomed to hear of the enormous volumes of water brought into Rome by the aqueducts which existed about the beginning of our era, and described by Frontinus, and I have always thought there must be some exaggeration about the figures. In those days it is clear the full volume of water was not gaged either at the intake or the delivery ends of the aqueducts, and no one seems to have understood the methods of calculating the quantity from the slope and sectional area.

Frontinus's estimations were based on the discharge of a number of ajutages or apertures of various sizes, and he did not appreciate the difference between the discharge of, say, 100 separate 1-inch apertures and that of one aperture whose sectional area was the sum of the aggregated 100. His standard ajutage or unit of measurement for water in motion was a "quinaria," or circular aperture 0.632 of an English square inch.

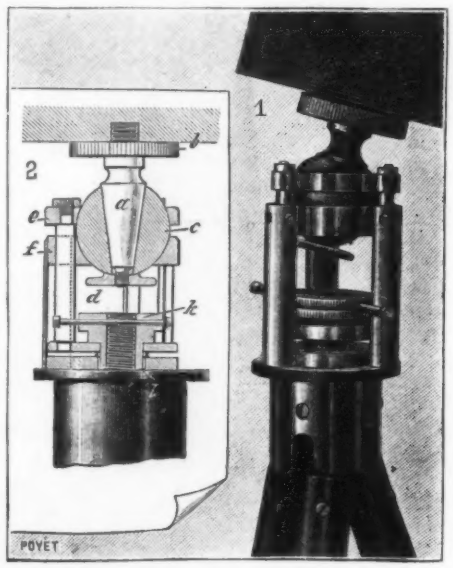
Mr. Herschel claims to have discovered that Prony was at the bottom of the erroneous estimations of the total quantity delivered, as in the "Memoires de l'Academie Royale, A. D. 1817," Prony says: "*If* we asume that the head acting on the quinaria was equal to its length—this being the custom in Rom in 1810 with respect to the 'oncia Romana'—and *if* we assume a discharge freely into the air, the value of the quinaria will be so many gallons per 24 hours."

Every writer since then, except Blumenstihl and Belgrand, has ignored the two *ifs* of Prony: then, using his conjecture as a fact, and otherwise exaggerating quantities, has stated the consumption to have been about 312,000,000 gallons in 24 hours. But these figures are absurd, for they would necessitate velocities in the aqueducts which could not possibly exist, and after a painstaking study of all the conditions of the sources, conduits, and distributing appliances, Herschel finally comes to the conclusion that instead of the 312,000,000 gallons, a more likely quantity to be carried daily by the nine aqueducts of which Frontinus had charge was about 70,000,000 gallons, 25,000,000 gallons being lost or utilized en route, and 45,000,000 gallons delivered into the city. But we know, both from Frontinus and Pliny, that the nine aqueducts were seldom all in working order, two or three generally being out of use for repair. For this fact it will be right to make a still further deduction, probably to 32,000,000 gallons, or, on the assumed population of that date of 1,000,000, 32 gallons per head per day.

This may not seem a very large quantity, considering the great volumes undoubtedly used for baths and fountains, but, on the other hand, we must remember that for purely domestic purposes the greater part of the people used only such water as was carried to their homes in jars upon the heads of slaves and other women, and that many local sources were also available.

THE CYROPLANE.

TRIPODS designed for photographic and topographic apparatus generally carry a small circular platform



THE CYROPLANE

1. General View. 2. Details of Construction.

or table provided with a screw that engages with a nut operatively connected with the apparatus. Such an arrangement is adequate when the latter is to remain horizontal, but permits of inclining it only through the extension of one of the legs. The use of a ball and socket joint would prove effective if the ball, when in the proper position, could be firmly fixed therein. But this is not always possible, on account of the method of tightening adopted, which is defective; and if the apparatus to be supported is rather heavy and its inclination upon the horizontal somewhat pronounced, it may abruptly take a greater inclination than it ought to. Besides, when the position, with respect to the line of the horizon, has been obtained it is necessary, in order to cause the apparatus to describe a circumference in the plane chosen, to loosen the ball, and the consequence is that the primitive position cannot be found again except by lengthy tentatives.

In the "Cyroplane," which he has had constructed by M. Balbrek, M. Simmonet offers an arrangement that seems to us to solve the problem perfectly. This device is screwed directly to the top of the tripod, and to this effect the circular plate that forms the base of it is provided with a nut, with which engages the screw of the ordinary leg. Upon this plate are mounted three columns that support a stationary ring, *f*, of a diameter slightly smaller than that of a sphere, *c*, which rests upon it. Another ring, *e*, of the same diameter as the first, is placed upon the sphere and connected by rods with a lower platform upon which acts a nut, *k*, having a milled edge. Upon revolving this nut the ring, *e*, is lowered, and the sphere is tightly locked. The sphere is provided with a conical aperture, into which enters a key, *a*, of the same form. It is this key that carries the plate, *b*, provided with the screw designed to secure the photographic or topographic apparatus to the tripod. At the lower part it is provided with a thumb-nut, *d*. If the inclination is to be slight, the latter is useless. It may be seen that through such arrangements it is possible, if need be, to obtain an inclination of any apparatus fixed at *b* by acting upon the nut, *k*. The apparatus may be afterward placed in any direction in the same plane without any attention having to be paid to the ball, which is rendered entirely immovable. This arrangement is very convenient for taking plans with the plane-table, and will render especial service to photographers, since, notwithstanding its small bulk, the Cyroplane is capable of easily supporting a 7 by 9-inch apparatus. It will be found very useful in the taking of panoramic views. M. Vallot, who presented the apparatus to the French Society of Photography, dwelt particularly upon this point, and no one is in a better position than he to discuss it, since it was he who made the panoramic view of a part of Mont Blanc that figures at the exposition of the Alpine Club. He had to take this view from an elevated point in inclining his apparatus at a considerable angle. The series of small negatives that he took is shown in the same hall with the panorama, and it may be seen that the junctions are very exact. The painting is merely an enlarged reproduction. M. Vallot, in his operations, employed processes that are peculiar to him; but, in work of this kind, a special support easy to handle in all planes will always be a guarantee of good and rapid execution.—La Nature.

CONTEMPORARY ELECTRICAL SCIENCE.*

EFFICIENCY OF ACETYLENE FLAME.—Experiments carried out at Cornell University by E. L. Nichols show that the total efficiency of the acetylene flame is superior to that of any other except the magnesium flame. The total efficiency is compounded of the luminous and the thermo-chemical efficiency. The luminous efficiency is the percentage of the total radiation which consists of visible light. That percentage is 1.5 in the paraffin candle, 2.6 in the oil lamp, 1.2 to 2.4 in the gas jet, 5 to 6 in the glow lamp, 2 to 7 in the incandescent gas lamp, 12.5 in the magnesium band, and 32 in the vacuum tube. The arc light has a luminous efficiency of 10.4 and the acetylene lamp of 10.5. The thermo chemical efficiency of the acetylene lamp (i. e., the ratio of radiation calories to total calories due to chemical combination) is 0.225. Hence the total efficiency is $0.225 \times 0.105 = 0.0236$. Another experiment carried out with a larger flame ("normal" size) gave 0.0190. This is at least double the total efficiency of the arc light, though, of course, this total efficiency has nothing to do with "financial" efficiency or cheapness. Otherwise the magnesium light, with its wonderful efficiency of 0.1025, would be the cheapest source of light.—E. L. NICHOLS, Phys. Zeitschr., January 12, 1901.

POLARIZATION BY ALTERNATING CURRENTS.—If a voltmeter is introduced into an alternate-current circuit, the quantity of electricity passing the voltmeter during a semi-period may produce three different effects—it may produce small polarizations; it may produce polarizations approaching the maximum; or it may saturate the electrodes and produce electrolysis. In the first case, the polarization shows a sinusoidal course, in the second it is approximately sinusoidal, with curves flattened at the apex, and in the third case the curve consists of straight lines representing the maxima joined by portions of sinusoidal curves. F. Oliveri has proved this behavior experimentally by means of Joubert's method of momentary contact, in which the terminals of the voltmeter are brought instantaneously into connection with a quadrant electrometer at definite phases of the current. The occurrence of electrolysis depends not only upon the difference of potential, but also upon the period, since the passage of a definite quantity of electricity is required in each semi-period to annul the polarization of the previous semi-periods. The current intensity is 90 deg. ahead of the electric polarization. The author describes a new method of measuring this phase-difference. With small polarizations, a voltmeter behaves like a capacity.—F. OLIVERI, Phys. Zeitschr., January 12, 1901.

STRATIFIED DISCHARGE.—E. Riecke is of opinion that the explanation of the stratified discharge must not be sought in the analogy of any wave motion like Kundt's dust figures, but rather in the analogy of a fluid jet which periodically expands and contracts as its distance from the orifice increases. Cathode rays, proceeding as they do by projection from the cathode, may behave substantially like a jet, as they leave the cathode with a definite initial velocity. He attempts a mathematical investigation based upon the supposition that the electrons move in the direction of the lines of force of a uniform electric field in a jet in which all the electrons throughout a cross section have the same velocity, and he supposes also that the electro-dynamical forces between the electrons are governed by the law of Clausius, and that the space through which the jet moves is filled with a neutral substance exerting a viscous retardation upon the jet. The curve of velocities then becomes a periodic one, and consists of an exponential curve and a sine curve of increasing amplitude superimposed. When there is no viscosity, the periodicity disappears. The same thing happens if the initial velocity is very small. This would cover the cases of high vacua and of feeble discharges. No allowance is made for the formation and decomposition of neutral molecules, as in Thomson's theory. G. T. Walker has, however, arrived at similar conclusions from the kinetic theory of gases.—E. RIECKE, Phys. Zeitschr., January 12, 1901.

DAILY VARIATION OF ATMOSPHERIC ELECTRICITY.—Like all periodic phenomena, the diurnal variation of potential at any point in the atmosphere may be represented by the superposition of sinusoidal curves having a day, half a day, one-third of a day, and so on, for their periods. But such a Fourier series does not necessarily correspond to natural periods, but rather tends to disguise them. It is, therefore, more fruitful to arrive in some way at the probable periods and then to determine their relative amplitudes. As a matter of fact, it is necessary to proceed to the fifth term at least of a Fourier series before a fairly satisfactory representation of the actual curve of atmospheric potential is arrived at. A. B. Chauveau, therefore, confines his at-

* Compiled by E. E. Fournier d'Albe in The Electrician.

tention to the diurnal period, and superimposes upon that a "disturbing wave," which is the resultant of all the smaller terms. Each of these curves has equal areas above and below the medium line. The area of the disturbing curve is about 0.35 of the main curve at the Paris Central Bureau, and 0.20 on the Eiffel tower in summer, and 0.10 in winter. The irregular disturbances are probably confined to points below the 100-foot level.—A. B. CHAUVEAU, Comptes Rendus, December 31, 1900.

ELECTRIC LIGHTING FOR RAILWAY CARS IN GERMANY.

THE recent deplorable railway accident at Offenbach-on-Main has led to a sharp and thorough inquiry into the danger which may attach to the illumination of railway passenger cars by means of gas and the greater comparative safety of electric lighting. The accident referred to was a collision between the rear car of a vestibule express train backing to repass a block signal which had been overrun in a thick fog and the engine of a local passenger train which was following the express. The engine crushed its way through nearly half the length of the car, killing many of the passengers in the five rear compartments, of which the car comprised ten, all opening into an aisle or passageway along the side of the carriage.

In this crush, the chimney of the engine was cut away and the front of the boiler so broken in that the smoke and flame from the flues poured out into the wrecked car.

The passengers in the front sections of the car escaped by the door and windows; but before aid could reach the survivors in the rear ones there was a loud and powerful explosion, which tore the wreck to splinters, set the interior on fire, and sealed the fate of those who still remained alive. This was the original and generally accepted account of the affair, although the railway officials have claimed, and the official report tacitly admits, that the explosion occurred later and when the whole interior of the wrecked car had been set on fire by the engine and was all ablaze, the point of contention being that the explosion did not of itself increase the loss of life.

However this may have been, the explosion did occur, and its nature and origin are thus explained: The car was lighted by what is known as the Pintsch system, and the supply of gas was carried in two cylinders of galvanized-iron plate about 12 feet in length which hung lengthwise beneath the floor at the middle of the car. In the collision, both these cylinders were torn loose from their fastenings and thrown into transverse positions across the track, still beneath the car. Neither cylinder exploded, but the gas from their torn connections rushed out, and filled the car above, forming in a few moments a mixture of gas and air which, being ignited by fire from the engine, exploded, with the result above described.

The question of the moment is whether the Pintsch system of gas lighting for passenger cars, which has been during recent years practically universal on the State railways of Prussia, should not be replaced by electrical apparatus, and this theme the technical press is now discussing with great energy and earnestness. Under this system, rich coal gas, rendered still more luminous by a 25 per cent admixture of acetylene gas, is compressed into cylindrical reservoirs and burned in specially devised lamps by burners which automatically adapt the flame to the varying pressure in the cylinders. In itself this enriched gas is not explosive, but it naturally forms an explosive mixture when combined with a certain percentage of atmospheric air. The system has been recognized as a great improvement over the stearin candles, colza oil, kerosene, and other lamps which had been previously used, and was regarded as satisfactory until electric lighting came into general use in streets and buildings. About ten years ago experiments were begun on the express trains, Frankfurt-Bebra and Stuttgart-Halle, with an electric system in which a small dynamo, placed in the baggage car and geared to an axle of the running gear, generated electric current at a voltage sufficiently above the point of utility to give a surplus which charged a small storage battery, that supplied the lamps when the train was not in motion. This worked so satisfactorily that in 1893 electric lights were adopted for the postal cars, of which there are about three thousand in use in this country.

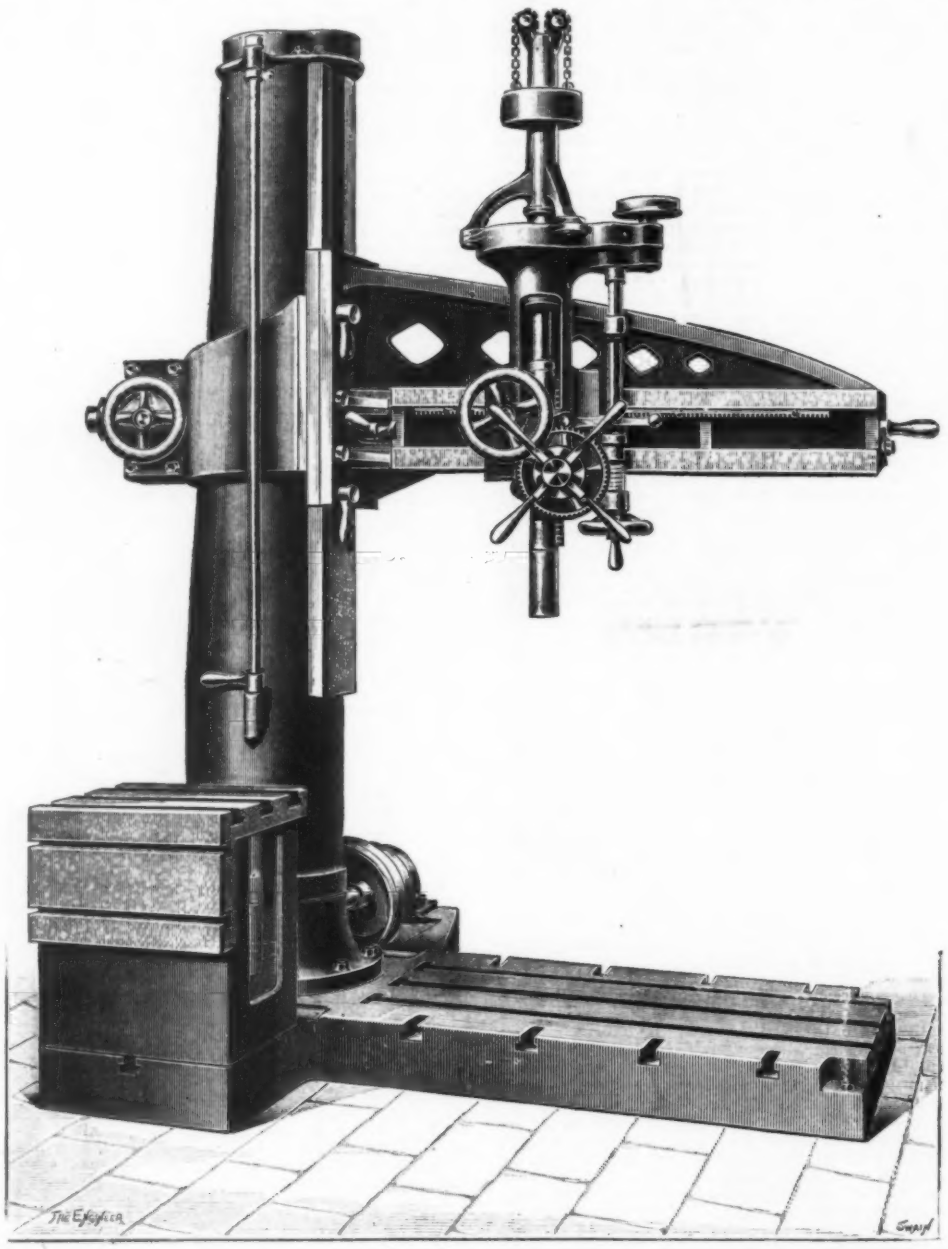
A postal car requires for ordinary service the illumination afforded by about fourteen full gaslights, which latter not only consumed rapidly the oxygen in the car, but in summer heated it to such a degree that what with heat, vitiated air, and varying light supply the comfort, health and eyesight of the employes were seriously compromised. For this reason, the electric light has become all but universal in the postal cars of Germany, each of which either carries its small dynamo and accumulator, and thus operates independently, or is provided with storage batteries that are charged from an outside source before the car begins its journey. The storage battery used for this purpose is of a type known as the Böse accumulator, four of which, each containing eight cells, carry sufficient energy to supply nine to eleven 12-candle incandescent lights during two nights.

Although this system, as well as the self-generating apparatus used in the two express trains above cited, has worked satisfactorily, it is recognized that the general substitution of electricity for gas in railway lighting throughout Prussia would involve not only large expenditures, but several important technical difficulties. To discard wholly the Pintsch system would mean throwing away an immense store of costly apparatus and the purchase of an entire new outfit, in which no part of the old material could be used. During the period of transition, when part of the cars in a train would be equipped with gas and part with electricity, difficulties would occur which would be especially serious in Germany, where so many trains do not make their entire run intact, but are cut into sections for branch lines at one point and reassembled or added to at another. In the management of postal cars, which are loaded at the point of departure and make a uniform through run without change, the loading and unloading of charged and exhausted storage batteries involves no difficulty, but this is not the case with passenger cars.

Experiments are now being made on a train between Berlin and Cologne with the Stone system of electric lighting, in which each car carries a small dynamo geared to a wheel axle and an accumulator both hung beneath the floor of the car. This system has proved successful in England; but it is claimed here that the varying speed and stoppages of the train cause variation and unsteadiness in the light, which the accumulator does not successfully correct. Finally, the instances where gas has proved a source of actual danger in accidents have been so rare and its use has been on the whole so satisfactory that, in view of the cost and technical difficulties which a general substitution of electrical lighting would involve, expert opinion is still divided as to the wisdom or necessity of such a change.—FRANK H. MASON, Consul-General at Berlin.

TWO DRILLING MACHINES AT THE PARIS EXPOSITION.

Two drilling machines made and exhibited by Emile Chouanard, Aux Forges de Vulcain, Paris, are illustrated herewith. In spite of the assertion of the maker that the machines are of a *construction irreproachable et robuste*, we imagine that British tool makers will take exception to the form of the column



RADIAL DRILLING MACHINE AT THE PARIS EXPOSITION.

in both cases. In neither design does it appear sufficiently rigid for the size of the machine, although the second type at any rate follows closely an American pattern. In the first, for example, the diameter of the base appears very small for a machine which takes drills up to 2.4 inches diameter, and in the second, taking drills up 3.2 inches, the whole column is far less substantial than the widely-used box section standard. It is difficult to see the object of the peculiar design shown in the first. The upper part of the column rotates round the inner cylindrical part. We have no figures as to how far the cylinder projects into the upper part, but from the fact that the horizontal spindle passes through the column it is fair to assume that it extends little more than half-way up. Why the end of the radial arm was not made to embrace a plain cylindrical column we are unable to say. The machine, it will be seen, is not inconveniently arranged, and the method of inclosing the gear is neat if unusual. Means are provided for readily locking the radial arm both for height and position, and for raising and fixing the table. Eight different cutting speeds can be given to the spindle, and a reversing gear is provided for tapping. The second illustration shows a larger machine, drilling holes up 3¼ inches in diameter. The whole column revolves with the arm, and is mounted on friction rollers. Special means are provided for clamping the arm at any height. The machine can be operated entirely by the levers on the carriage. Friction gear is employed, and the spindle has a rapid reverse. The drill spindle is graduated, and there is an automatic knock-out. The speed is altered rapidly by the simple movement of a lever. All nuts in frequent use are provided with fixed levers, obviating the use of spanners—a point which some British makers would do well to observe. It will be seen that there are excellent points about both machines, although the general designs do not seem to us all that could be desired.—Engineer.

GOLD PAINT.

By W. A. DAWSON.

THE formulas of the various gold paints on the market are carefully guarded trade secrets. Essentially they consist of a bronze powder mixed with a varnish. The best bronze powder for the purpose is what is known in the trade as "French flake," a deep gold bronze. This bronze, as seen under the microscope, consists of tiny flakes or spangles of the bronze metal. As each minute flake forms a facet for the reflection of color, the paint made with it is much more brilliant than that prepared from finely powdered bronze.

For making gold paint like the so-called "washable gold enamel" that is sold by the manufacturers at the present time, it is necessary to mix a celluloid varnish with the French flake bronze powder. This varnish is made by dissolving transparent celluloid in amyl acetate in the proportion of about five per cent of celluloid.

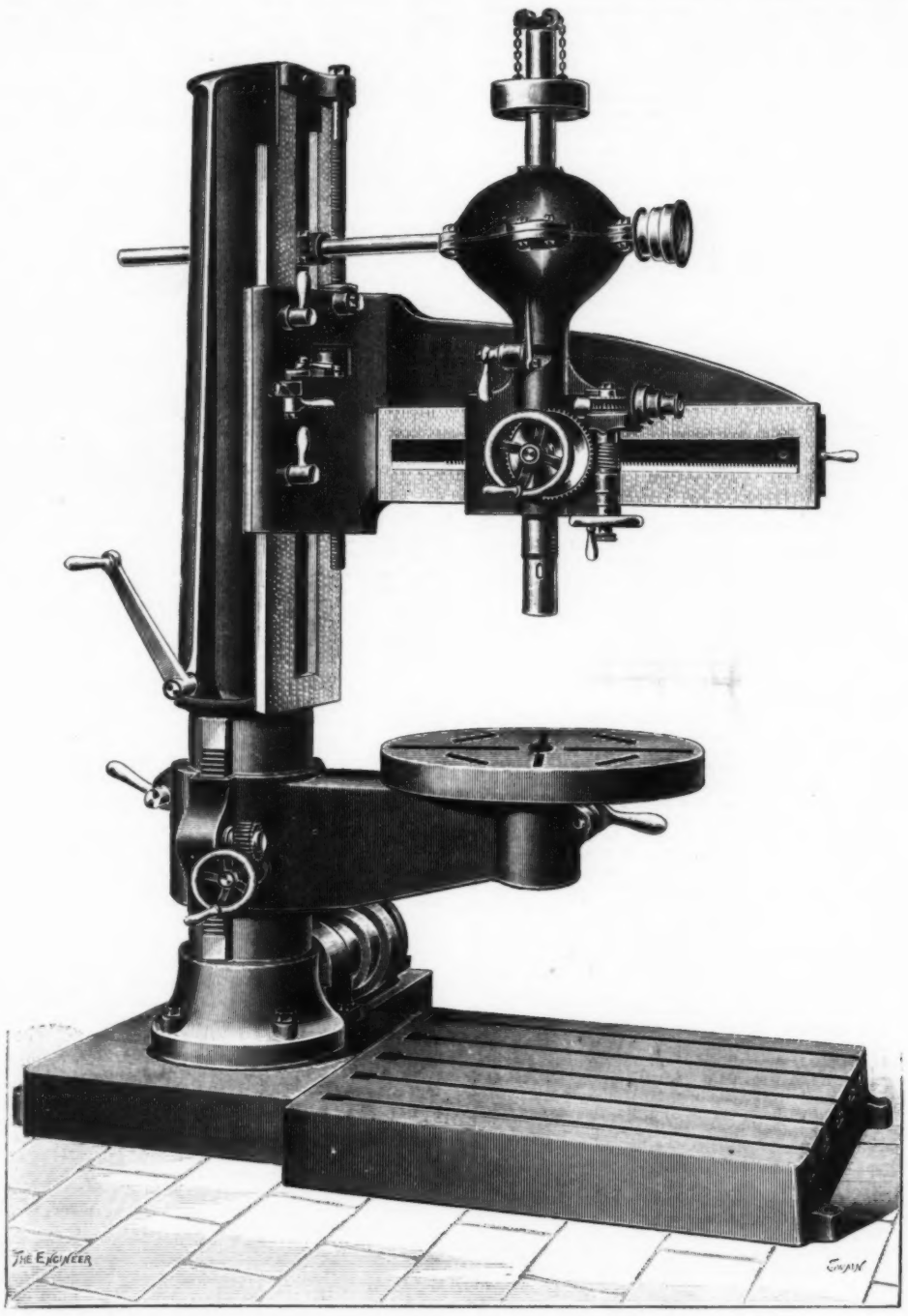
Transparent celluloid, finely shredded.1 ounce.
Acetone, sufficient quantity.
Amyl acetate.....to make 20 ounces.

Digest the celluloid in the acetone until dissolved and add the amyl acetate. From one to four ounces of flake bronze is to be mixed with this quantity of varnish. For silver paint or "aluminium enamel," flake aluminium bronze powder should be used in place of the gold. The celluloid varnish incloses the bronze particles in an impervious coating, air-tight and water-tight. As it contains nothing that will act upon the bronze, the latter retains its luster for a long period, until the varnished surface becomes worn or abraded and the bronze thus exposed to atmospheric action.

All of the "gold" or, more properly, gilt furniture that is sold so cheaply by the furniture and department stores is gilded with a paint of this kind, and for that reason such furniture can be offered at a moderate price. The finish is surprisingly durable, and in color and luster is a very close imitation of real gold leaf work. This paint is also used on picture frames of cheap and medium grades, taking the place of gold leaf or the lacquered silver leaf formerly used on articles of the better grades; it is also substituted for "Dutch metal," or imitation gold leaf, on the cheapest class of work.

A cheaper gold paint is made by using an inexpensive varnish composed of gutta-percha, gum dammar, or some other varnish-gum, dissolved in benzole, or in a mixture of benzole and benzine. The paints made with a celluloid-amyl-acetate varnish give off a strong banana-like odor when applied, and may be readily recognized by this characteristic.

The impalpably powdered bronzes are called "lining" bronzes. They are chiefly used for striping or lining by carriage painters; in bronzing gas fixtures and



RADIAL DRILLING MACHINE AT THE PARIS EXPOSITION.

metal work; in fresco and other interior decoration, and in printing; the use of a very fine powder in inks or paints admits of the drawing or printing of very delicate lines.

Lining bronze is also used on picture frames or other plastic ornamental work. Mixed with a thin weak glue sizing it is applied over "burnishing clay," and when dry is polished with agate burnishers. The object thus treated, after receiving a finishing coat of a thin transparent varnish, imitates very closely in appearance a piece of finely cast antique bronze. To add still more to this effect the burnishing clay is colored the greenish-black that is seen in the deep parts of real antique bronzes, and the bronze powder, mixed with size, is applied only to the most prominent parts or "high lights" of the ornament.

Since the discovery of the celluloid-amyl-acetate varnish, or bronze liquid, and its preservative properties on bronze powders, manufacturers have discontinued the use of liquids containing oils, turpentine, or gums, since their constituents corrode the bronze metal, causing the paint to finally turn back.—Bulletin of Pharmacy.

OBSERVATIONS ON CROOKES TUBES.*

By H. WESTBURY.

CATHODE rays are supposed to be produced at a pressure of about a millionth of an atmosphere. They are generated from any sources of electricity with voltage high enough to force a discharge through a Crookes tube. They proceed perpendicularly from the surface of the cathode in straight lines and fall upon the opposite wall of the tube, producing fluorescence. If any object be placed between the cathode and the opposite wall of the tube, a black shadow of the object is cast upon the wall of the tube. The path of the rays is entirely independent of the position of the anode. They can be deflected from their straight path by either pole of a magnet. Two parallel streams of cathode rays repel each other. If the rays falls upon a balanced object in the tube it will rotate. Making the cathode concave and so bringing the rays to a focus heats the anode rapidly. The glass walls of the tube are opaque to the cathode rays. The X-rays are supposed to be produced at the same time as the cathode rays, originating at the end of the latter and passing out of the tube into the air. They produce fluorescence in certain chemical compounds, such as tungstate of calcium, platino-cyanide of barium, etc. Wood, paper, cloth, metals, flesh, etc., are transparent to the rays, although not to the same degree. The rays affect photographic plates, and thus give shadow photographs of objects otherwise concealed. They are not believed to be light rays, as they cannot be reflected, refracted or polarized. Two views are held as to the nature of the cathode ray; one, that these rays are a radiation in the ether, probably transverse waves like light, hence they are sometimes called ether waves; the other, that they are streams of particles of the gas still left in the tube projected from the cathode. If, however, rays can be produced in a tube entirely free from air, it is evident that the second theory is incorrect. If there is left a small hole in a tube, and a thin plate of aluminium sealed in, the cathode rays pass out and can be deflected with a magnet. This first theory is well supported, but does not explain why a magnet deflects these rays or why two cathode streams repel each other, as nothing similar is known in light radiation.

It was early appreciated that the three things in which great improvements were necessary were the exciting apparatus, the fluorescing screen and the Crookes tube. With the first I have nothing to do in this paper. The screen has unfortunately stood practically where it started until now, in spite of numerous experiments with all kinds of salts, of which the following have been found to fluoresce in varying degrees, viz., platino-cyanide of barium, tungstate of calcium (these fluoresce better than any other salts at present known), tungstate of strontium, subchloride of mercury, mercury diphenyl, cadmium iodide, sulphide of calcium, potassium bromide, potassium iodide, tetrametaphosphate of lead, mercurous chloride, bromide and sulphate of lead, fluorite, powdered lead glass, pectolite, sodium cressotinate, ammonia salicylate, calcium salicylate and salicylic acid.

Neither tungstate of barium nor lead fluoresces appreciably. There are a large number of other chemical and mineral salts which also fluoresce, but not to so great a degree as those above mentioned. Among these may be mentioned powdered German glass, barium fluoride, calcium fluoride, sodium fluoride, sodium chloride, mercuric chloride, cadmium chloride, silver chloride, lead chloride, lead iodide, sodium bromide, cadmium, lithia bromide, mercury, cadmium sulphate, uranium phosphate, nitrate of uranium (which fluoresces almost as well as tungstate of calcium), acetate of uranium, molybdic acid, silicate of potash, sodium bromide, wulfenite, orthoclase, andalucite, herdinite, apatite, calcite, and many others.

Sulphide of zinc and sulphide of calcium can both be used for strengthening screens in contact with X-ray plates. Tungstate of calcium, at first generally used for this purpose, has been universally superseded by platino-cyanide of barium, which, however, is extremely troublesome to handle, owing to its unstable nature, the least friction or dirt spoiling it. In my opinion, therefore, a cheaper and more durable fluorescing substance is much to be desired.

The Crookes tube is important in the production of X-rays, as at the present time it is the only practical way of producing the rays for medical use. Such tubes are, generally speaking, made of flint glass, although lead glass can be used, but is more opaque. Originally it was laid down as a fact that lead glass would not produce X-rays at all. Ordinary ruby glass is also opaque to the rays, and it appears that the rays will not pierce certain colors. The red-tinted glass used in some English tubes is not ruby glass, but simply due to minerals in the glass not necessarily opaque to the rays.

It is extremely interesting to watch closely the vagaries of various tubes after re-exhaustion on the pumps. Some will fluctuate in vacuum, one minute going very high and the next so low that no rays are generated. This can sometimes be driven out of the tube by heating the anode to a white heat and then allowing it to cool off before again repeating the process which we call "curing" a tube. All the best vacuum tubes are treated in this way, as it has been found by experience that tubes exhausted too high on the pumps never give the results obtained from tubes taken off at a lower vacuum and then electrically cured. If I remember correctly, our friend, Dr. Rollins, has demonstrated this fact in his interesting notes on X-light. Other tubes behave very curiously. Some will throw a peculiar patch of fluorescence in certain parts of the tube; others will be of high vacuum and give a reversed current, and the other week I even obtained a German tube with an aluminium ring in the center, which, after re-exhaustion, gave a reversed current at a very low vacuum—a phenomena I have never observed before. It is no exaggeration to say that no two tubes behave exactly alike, although, of course, tubes can now be made so uniform as to lead any outsider to believe there is no distinction in them at all.

There is quite a difference of opinion as to the correct situation for the cathode, whether just inside the bulb or inside the terminal, and this difference seems to have been in existence for several years, as I remember reading an article two or three years ago, claiming that the cathode inside the bulb was of no use for coil tubes, but immaterial for static current. Personally, I have failed to find much variation, and am inclined to think that, within reasonable limits, any size cathode and any position gives about the same results, but at the same time I believe that a good deal depends upon the concavity of the cathode, and, of course, liability to puncture has to be considered in placing the cathode, more especially on a static tube. Theoretically speaking, however, the quantity of current should govern the size of the cathode. While it is probably true that a focus right on the center of the anode is best, yet the benefit obtained is so small that so long as the cathode stream impinges on some part of the anode disk, X-rays are present in abundance. Sometimes one gets an old tube with the anode twisted and bent out of all shape, and even with a hole right through it, which yet gives magnificent results.

Another curious phenomenon is the peculiar blackening of the glass bulb after continual use. Many explanations have been brought forward to account for this discoloration, but so far none of them seems plausible, and probably until we solve the exact nature of the rays themselves, we cannot tell what causes this deposit on the bulb. One thing I can say, however, that tubes giving fine phosphorescence blacken less than others. It used to be considered that the more phosphorescent a tube was the better X-rays it would generate, but this cannot be proved, as I have many tubes with little or no phosphorescence giving as good results as those made out of the most luminous glass. This luminosity is also a very curious phenomenon. Sometimes it appears evenly all over the bulb, the glow lasting for a considerable time after the current is turned off. Sometimes it is only present in small portions of the bulb, and occasionally I have seen it represented by simply a luminous shad-

* Paper read before the Roentgen Society of the United States at New York city on December 14, 1900.—Western Electrician.

ow of the anode thrown on the otherwise black wall of the tube.

To the outsider the evolution of the present perfected form of Crookes tubes from the types originally used shortly after the X-rays were discovered does not present very many features striking to the eye, but to those who have been closely following these changes they have improved very steadily every year. The original types of tubes were of the kind in which the cathodic stream of rays was thrown on the glass of the tube itself. While this type of tube was at first successfully used, the necessity for a tube which would focus the rays soon became apparent. After numerous experiments with various contrivances for attaining this result, tubes were produced with aluminium cathodes and platinum anodes, and these have held their ascendency up to the present time. Since that date constant experimenting has led to something approaching a standard shape for Crookes tubes. The bulb was gradually changed from the oval and tubular shape to globular, although some of the very earliest types were made spherical. The distance between the anode and cathode with which the best results could be obtained was gradually determined. The terminals were extended to meet the increasing efficiency of the apparatus used for the excitation of the tubes, which caused the current to spark across, and many minor details in connection with the sealing in of the terminals and proper supporting of them, to enable a tube to be transported without danger of breakage were made. Of recent date we have the reinforcement of the anode with other metals to enable it to stand up against the heavy currents now used, and the endeavors to focus all the rays in a circle on the front wall of the tube, so that none of them may be useless by passing out where they are not required.

One of the earliest troubles met with in tubes was their tendency to increase gradually in vacuum, until at length they became so high that the current would not pass through them, and even if an enormous spark were used, the resulting rays were so highly penetrating as to be of no practical use. This led to the devising of the adjustable vacuum feature which is now so prominent in most tubes sold in this country. Originally ordinary potash was used, inclosed in a small auxiliary tube and liberated by means of applying a match or Bunsen burner. This lowered the vacuum, certainly, but only for a few minutes, when it jumped up again as high as before. Many operators also cracked their tubes, owing to heating the auxiliary tube too much, and many present will remember the burned fingers which sometimes resulted. To meet this difficulty, the present types of adjusters were designed with a wire terminal, so that an electric spark can be discharged directly through the auxiliary tube, and better salts and combinations were obtained, which regulate the vacuum a great deal better than formerly, but, of course, this is not yet by any means perfect.

Both osmium and iridium have been used for the anode, but both of these metals generate so much gas that it is very difficult to exhaust a tube containing them, and even then, after use, such a tube will continually run too low for the production of rays, in addition to which the cost is prohibitive for a commercial tube. I am inclined to believe that for some of the finer forms of X-ray work the tubes with water-cooled targets may prove useful, but unless such a tube can be designed much cheaper than at present their cost is also prohibitive.

I particularly wish to bring before this meeting one point which I very much desire to impress upon tube purchasers generally, and that is the advisability of our trying to standardize American glass for Crookes-tube use. There is, unfortunately, at the present time a color fancy among many Crookes-tube operators, who insist upon having tubes which give an apple-green effect. Now it is a fact that this has nothing whatever to do with the strength of the rays given out by such tube, and tubes made of American glass giving a whitish or yellowish color illuminate a screen just as brightly as one made from the best green German glass. My reasons for raising this point, apart from the patriotic one of using home-made materials, which, however, ought to have a little weight, are that the domestic glass, is, as a rule, stronger and freer from blisters, cords, air bubbles, etc., which tend to make a tube liable to puncture, and also, what I think is the most important reason for purchasers of tubes to consider, that the domestic tubes are much more easily repaired.

I am not in favor of using a larger bulb for a Crookes tube than about five inches, as I do not think that there is any better definition or even field obtained by using larger bulbs. Of course, for very heavy sparks, an 8 or 10-inch bulb is probably an advantage.

An interesting experiment with the double-focus tubes on alternating current is to run them in multiple series, which can easily be done by wiring each of the two cathodes together. Of course, the field is somewhat enlarged, but as I have never taken a large radiograph this way I cannot say whether this arrangement is of much practical use. In multiple they do not run so well, and with single-focus tubes, as a rule, there is no benefit obtained by using more than one tube at a time.

The use of a very high vacuum or "hard" tube is of very little practical utility, as, while the rays are enormously penetrative, the definition obtained is not distinct or clear, and for very delicate work, such as observing the lungs, etc., the definition has to be as clear as it is possible to obtain.

Dr. Lenard, of Philadelphia, has recently done some excellent work in the line of penetrating the inmost recesses of the organs, and I have several times verified his published statements. The following is, therefore, interesting:

In cases of calculus, a soft tube is required, as the rays must differentiate between the shadows of tissues less dense than the least dense calculus, and all calculi can be found. A soft tube is one having a low vacuum, and best results are obtained from such a tube with a large volume of Roentgen discharge. For lumbar and pelvic pictures the vacuum requisite is equivalent in resistance to from one to two inches of spark in air, as measured by a parallel spark gap. High wattage and not high voltage seems to be the necessary element in the current employed to energize a tube in such cases. Great difficulty is met with in obtaining such volume to penetrate these thicker portions of the bodies, unless a regulating tube is used, which permits the required volume of electrical energy to be forced through a tube without altering its resistance, eliminating the effect of heat, which, in a soft tube, either lowers the vacuum until it loses all penetration or raises it rapidly until the penetration is too great. It is this inherent tendency of a regulating tube that has been highly exhausted to regain its high vacuum after it has been lowered that makes it superior to an already soft tube that has never been high or hard. The vacuum of an initially soft tube will not remain steady while energy sufficient to develop the required volume of Roentgen discharge for soft-tissue work is forced through it.

While the cause of X-ray burns is still in dispute, I would like to state that I believe, in common with several other observers of tube phenomena, that they are only caused by certain tubes, and that the trouble is in the tube itself, at what point I cannot, of course, say, but I firmly believe that there is some little difference which causes the rays to burn, or, more properly speaking, causes dermatitis. However, militating against my theory, to some extent, is the fact that Dr. Scott and other operators have found that the funnel-focus type of tube, which probably focuses more of the rays on one spot than any other type of tube, causes dermatitis after very short exposure, which would tend to show that the old theory of the more powerful the rays, the more the tendency to burn, is correct.

THE OPTICS OF TRICHROMATIC PHOTOGRAPHY.*

I.

THE search for a direct method of pigmentary color photography, such as was dreamed of by the fathers of photography and the world at large, appears to have been practically abandoned, every seeming clew to such an achievement having proved a delusion. Nevertheless, so much has been accomplished in the direction of practical color photography by indirect methods, that the subject has become a very large and important one, and so specialized that it would be impossible to do justice to it in a single lecture, or even in a treatise of considerable size. I even doubt if any one man possesses such a full knowledge of both the science and history of this subject as would make him competent to treat it fully, and with absolute impartiality.

This is the more surprising in that every method which has achieved or promises to achieve a notable degree of practical success is based upon the same underlying idea of a composite trichromatic image.

The most that I can hope to do in this lecture is to give such a concise critical review of the history, and science, and mechanism, of these methods as may serve to disclose the conditions of success, and help to clear away some of the lumber of ignorance and misconception which has stood and still stands in the way of general progress.

I have chosen to treat the subject historically, as well as practically, not only because the history of the subject is very interesting in itself, but because by no other means can correct methods be established so well as by critical comparison with incorrect methods, which to the mind of the layman may appear to have been reasoned out with equal logic, and to superficial observation with even greater definiteness.

It is my sincere wish to give full credit to the pioneers of these methods, but at the same time to clear from the path the stumbling-blocks of their errors and misconceptions, for I have observed that the very men who commence and carry forward a great work often leave it encumbered with rubbish which impedes further progress, and which must be cleared away by somebody before the defects can be corrected and the work carried on to perfection.

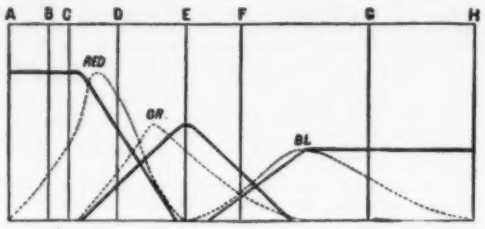
I have myself devoted many years to trying to clear away the rubbish, correct the mistakes, and supply missing material to bring this work to perfection, and I presume that I may accept the honor of being asked to prepare this lecture as a recognition of my efforts, and a justification for such a treatment of the subject as must have been expected from me, in the light of my past record as a writer upon this subject.

I purpose to begin with a concise statement of the principles of successful trichromatic photography, and to follow with an analysis of the various methods which have been proposed, showing the progress toward the recognition and attainment of the conditions of success, and at the same time the specific defects of each method and device; but, for greater clearness, I shall divide my subject into sections, treating first of the principles of the more important processes, then of the optical and mechanical inventions designed to facilitate their practice, and last of all of special developments of the idea, and the optical devices pertaining thereto.

The trichromatic process of color photography consists essentially in (1) the production of three photographic images which represent the physiological analysis of all colors into three simple spectrum colors, and constitute a color record, and (2) synthesis by optical superposition of the three elements of the color record in the three simple colors, whereby the sensations of all the original colors are reproduced to the eye.

Such analysis and synthesis is possible because there are three spectrum colors, which by admixture in suitable proportions will reproduce to the eye the sensation of every other spectrum color. These three simple colors are the red of the spectrum, about the Fraunhofer line *C*, the green near *B*, and the blue near *G*.

What particular colors must be employed, and the proportions in which they must be mixed to reproduce to the eye the sensation of the intermediate spectrum hues, was first determined by Prof. James Clerk-Maxwell, and is shown by his famous "color curves," which I reproduce.



These factors have been redetermined by Sir William Abney, with an improvement upon Maxwell's color box, but Maxwell's results are shown to be *substantially* correct, and I therefore prefer to use Maxwell's diagram in illustration, because of its historical bearing upon the subject.

Maxwell's curves are *color-mixture* curves, and not to be confounded with *color-sensation* curves, which assume a fundamental green sensation which no part of the spectrum excites exclusively. In trichromatic photography we have to deal with mixtures of actual spectrum colors.

The relative height of the respective curves at any point indicates the proportions of the simple colors required to reproduce to the eye the color of the spectrum at that point.

It follows that in order to obtain a trichromatic color record of the spectrum itself, three photographs of the spectrum must be made, in each of which the distribution of photographic action is such as would be represented graphically by the respective curve in Maxwell's diagram.

The picture to represent the red element in the analysis must be made not only by the action of the red rays, but by the action of orange-yellow, and yellow-green rays, in proportion to the relative amount of red light required to represent the latter colors in the synthesis, by admixture of green; and, as shown by the "red" curve in Maxwell's diagram, the strongest action of all, instead of being in the red, will be in the orange, which is reproduced to the eye in its correct relative luminosity by mixing the greatest amount of red with a little green.

Similarly, the negative to represent the green element must be made by the joint action of orange, yellow, yellow-green, green and green-blue light, with the strongest action in the yellow-green, as shown by the second curve; and the third negative by the joint action of green-blue, blue and spectrum violet light, as shown by the third curve.

If the distribution of photographic action does not correspond to the form of these curves, the analysis will be imperfect, and correct synthesis becomes impossible. If the yellow of the spectrum does not act in both the red and green negatives, it must be reproduced either as red or as green; and if it acts in both negatives, but not in the correct relative proportions, it will be reproduced either as orange or as yellow-green. To insure accurate results, the photographic analysis must be a *quantitative* analysis, and a correct quantitative analysis and no other will admit of the synthetical reproduction of the spectrum itself, with all its gradations of color and luminosity.

All the colors in nature are mixtures of spectrum colors; therefore it may be taken as an axiom that *the ability or inability to reproduce the spectrum itself credits or discredits any trichromatic process.*

If you can obtain by photography such a color record of the spectrum as I have described, you can by the same means obtain true color records in photographs from nature and works of art; but, if the spectrum test in any ways fails, no real accuracy can be guaranteed or should be expected.

To secure negatives of the required character, we must employ color-sensitive photographic plates, and filter the spectrum rays through suitable colored mediums, testing by exposures in the photo-spectrograph and modifying the color filters until the density curves conform to Maxwell's color curves. Such adjusted color filters I term "color-curve screens." This system of photographic analysis I call "color-curve analysis," and the photographic records "color-curve records."

Although there are various methods of synthesis, positive (photo-chromoscopic) and negative (color prints), the photographic record that is correct for one is correct for the other.

An incorrect color record cannot be made to yield a correct synthesis by any means whatever.

Positive synthesis may be obtained by making a positive color record (a transparency) from the negative color record, and projecting the three images separately in three magic lanterns, each with light of the simple color which it represents, and all superposed in register to form a single sharp composite image upon the screen.

Lest a most important point be missed, I repeat that the synthesis must be obtained with the simple colors, red, green, and blue, although the records have been made by the action of mixtures of various spectrum colors. Thus, although the record for red is made by the joint action of red, orange, yellow, and yellow-green light, this image must be pure red in the synthesis. Correct synthesis, therefore, demands the use of "pure color" screens, in contradistinction to the "color curve" screens pertaining to the process of analysis.

If we were to use the same screens for both analysis and synthesis, the results, in dealing with the spectrum, could not possibly be correct. The reason for this should be evident to any one who has followed my argument, but in a few words I will give one or two illustrations.

Suppose we make our color records of the spectrum through "pure color" screens; then only the two ends of the spectrum and a band in the middle will be reproduced, the remaining portions appearing as broad, dark spaces in the synthesis, because such screens transmit none of the intermediate spectrum rays. Sup-

* The Third Traill Taylor Memorial Lecture. By F. E. Ives. Read before the Photographic Society of Great Britain.—From Br. Jour. of Photography.

pose, on the other hand, that we attempt the synthesis with the "color-curve" screens; the simple colors red, green, and blue, cannot be reproduced, because the respective screens transmit other spectrum colors along with these.

In short, it is absolutely necessary, in order to obtain a true color record, to photograph through "color-curve" screens, and correct synthesis is possible only with "pure color" screens.

It is true it may happen that, in dealing with compound colors, the effects of departure from theoretically correct conditions will not always result so disastrously as in dealing with the spectrum itself; but no reliance can be placed upon any but fundamentally correct methods.

It is also true that the habit of the eye and mind, due to familiarity with monochromatic photographic reproductions, makes some dilution of color acceptable to most people, but a recognition of the principle I have stated is necessary in order to introduce this dilution without change of *hue*. The dilution must be equivalent to admixture of white light only, and this is most perfectly effected by broadening the spectrum bands which are taken as synthesis colors without materially displacing them.

In positive synthesis we build up our composite color photographic image by adding light to light, red, green, and blue, as already described; but we may also employ a method of negative synthesis, producing fixed color prints upon paper or glass, in which case we commence with our white surface, and build up the picture by superposing colored shadows (transparent color prints) upon it.

This method is essentially complementary to the other, and the colors of the transparent prints are like the shadows of the corresponding positions in the white field of the triple lantern.

Red, green, and blue, being the colors in positive synthesis, *minus* red, *minus* green, and *minus* blue, or cyan blue, bright crimson, and yellow, are the printing colors.

If our white surface, against which these color prints are superposed, were a white made by mixing red, green, and blue spectrum rays, no further definition of the printing colors would be necessary. Inasmuch, however, as our white is ordinarily made up of all the spectrum rays, it becomes necessary to consider the absorption of the colors in the intermediate spectrum regions.

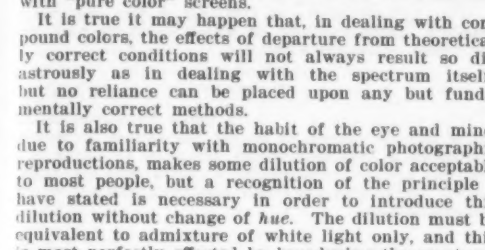
The function of the printing colors is to most efficiently subtract from *ordinary* white light the visual impression belonging to the respective simple color elements. In other words, the printing colors as seen in *ordinary* white light should appear to match as nearly as possible the *minus* (shadow) colors which may be produced in the physiologically white field of a device for positive synthesis.

This would not be accomplished by absorptions complementary to the correct photographic action, for the reason, for instance, that a *minus* red (*C* line) is considerably more antichromatic to the red element than a *minus* yellow (*D* line), although the yellow is more active than the red in the production of the respective negative, in accordance with Maxwell's curves.

I will give one practical illustration. The absorption of the dye cyanine is in approximate concordance with the Maxwell red curve, and, when it is used as a color sensitized on a suitable photographic plate, it yields a density curve also pretty close to the Maxwell red curve; but this color, in ordinary daylight, is no more like our *minus* red than cobalt-blue glass is like signal green.

The relative efficiency of the absorption falls as we go toward the next "primary" in the spectrum, because it involves simultaneous damping of the visual impression of that other "primary."

It follows from this that the absorption of the printing colors should not conform to the Maxwell curves, but should be greatest for the "pure" colors, and fall gradually to the position of the next "primary" in the spectrum. Such absorptions are shown in the diagram given herewith, the Maxwell curves being shown by dotted lines, and the printing color absorptions by the full lines.



These three absorptions, added together, make a neutral black or gray in ordinary white light, but absorptions according to the Maxwell curves would make a dark purple, because the pure red and violet spectrum rays would not be all absorbed. This drawing, although imperfect, sufficiently illustrates a principle which I have long recognized and tried to make clear to others.

I hope the illustrations which I have now given will make it sufficiently clear that in negative synthesis the printing color absorptions should differ from the photographic analysis curves for the same reason that in positive synthesis it is necessary to employ "pure color" screens instead of "color curve" screens; but it is also evident that the distinction cannot be as complete, nor the result as perfect, because of the different character of the white light in the two cases.

As I have frequently pointed out, and as analysis of all the absorption diagrams will prove conclusively, synthesis by color prints introduces a perceptible though not necessarily offensive dilution or degradation of colors, which, however, should disappear altogether if the prints are viewed in a mixture of pure red, green, and blue light.

In short, it is not possible, in ordinary white light, to reproduce all of the spectrum colors undiluted by means of any three printing colors, for the same reason that it cannot be done in positive synthesis by means of "color curve" screens; but the best approximation may be obtained by using the printing colors most specifically antichromatic to the respective color elements in ordinary white light.

Let me here emphasize the fact that the slight degradation of color which the spectrum test will disclose even with such printing colors as I have indicated is in no material degree the fault of the photographic analysis, but is inherent in the printing colors. Analysis of the absorption curves of *any* three printing colors will demonstrate that by no means whatever can they be combined to reproduce the spectrum without some dilution or degradation, which may be either general and reduced to the lowest minimum, as with the colors I have indicated, or localized, so as to introduce changes of *hue*, which would be far more objectionable.

It is also necessary to point out that the comparatively short scale of correct gradation of the photographic process is always working against a tendency to weaken color contrasts which might otherwise be expected, but also that, just in proportion as the color contrasts are thus intensified, other, and I think more important, qualities are sacrificed. It is generally far better to sacrifice something of the purity of colors than to alter their hues.

Synthesis by the positive method offers the advantage not only of far greater simplicity, but of yielding every other quality along with practically undiminished purity of color.

When I originally stated these propositions they were dismissed by many as "mere assertions," "speculations, unsupported by argument or experimental proof," "pretentious and unfounded judgments," "theories, which have nothing to do with practice," etc.

It has always seemed to me that they were such logical deductions from the experimentally verified facts of spectrum color analysis, that it would be an insult to intelligence to devote time and space to argument and illustration. I am of the same opinion still, but have, nevertheless, tried to fortify myself this time with some arguments and illustrations, which I think go as far as should be necessary for anybody who can comprehend a simple theory.

It was by adhering to the conditions which I have laid down that I succeeded, at a time when the capabilities of trichromatic photography were almost universally discredited, in reproducing test subjects to the entire satisfaction of a committee of scientists appointed to investigate the subject.

I shall now proceed to consider the genesis of the various methods which have been proposed, showing as well as I can what elements of success were contributed by each worker, and wherein each failed, until all the conditions of success were realized.

The first suggestion was made by Prof. James Clerk-Maxwell, in a lecture at the Royal Institution, May 17, 1861. This lecture was never published in full, but a report of it was printed in the Journal of the Royal Institution.* According to this report, he proposed the production of three photographs to represent the three fundamental color sensations, by exposing photographic sensitive plates through color filters, and synthesis by triple lantern projection through the same color filters. I am inclined to believe that the principle of color-curve analysis and pure color synthesis was fully recognized by Clerk-Maxwell, and that it was only by an oversight that this distinction was not set forth in the brief report of his lecture. In short, I believe that his invention may have been theoretically complete for the recording of colors by photography, and their reproduction by triple lantern projection, but that it was lost to the world by insufficient publication.

The next published suggestion was made by Henry Collen, in a letter to The British Journal of Photography (page 547, October 27, 1865). Collen, who accepted Brewster's theory of three primary colors of light, red, yellow, and blue, proposed the production of a separate negative by the action of each primary color, and negative synthesis by the production and superposition of transparent color prints. He suggested that the negatives should be made on thin pellicles, and that they should be superposed two and two to print transparent images of the third color; thus, the negative made by blue light and the negative made by yellow light should be superposed and used as one in making the red print, the red and blue negatives for making a yellow print, and the red and yellow negatives for making a blue print.

There were three defects in this proposition, any one of which would have been fatal. First, the wrong idea as to primary colors. Second, the fact that prints in true red, yellow, and true blue cannot be made to even approximately reproduce all colors. Third, that the combination of two negatives doubles the opacity of all whites and grays, without altering the opacity in the records of the pure colors.

The result of this would be that when the printing was carried far enough to show details in the whites (opaque in two negatives), the pure colors (each opaque in only one negative), instead of printing like the whites, as they should, would print half-way down to the deepest shadows in density, and reduce the relative luminosity of colors by nearly 50 per cent in the finished prints.

In a trichromatic color record, only one of the three color elements can be represented in each negative image in its proper relation to the whites and grays.

Collen's idea was to make one complete negative image by superposing two single element records.

Baron Ransonnet, in Austria, is also credited with a crude suggestion of trichromatic photography, in 1865.

Louis Ducos du Hauron, in France, applied for a patent on the trichromatic principle in November, 1868. Du Hauron elaborated the idea very much, suggesting not only triple negative color records, positive synthesis by triple lantern projection, and negative synthesis by superposed color prints, but also positive synthesis by a photo-chromoscopic apparatus, and a process in which a single screen made up of juxtaposed colored lines was substituted for three separate color screens, and the operation reduced to the production of a single photographic image.

Du Hauron displayed extraordinary ingenuity, but, like Collen, he was misled by Brewster's theory of color, and there were fatal defects in every method which he proposed.

One of his mistakes was in the assumption that pure color screens should be used in the photographic analysis intended for positive synthesis, and that the same screens should be used again in the synthesis. Another was that negatives of a totally different character would be required for the purpose of negative synthesis by superposed transparent color prints.† He recognized that the opacities of each of the three negatives intended for *positive* synthesis should represent a single color element only, but not that they should be made through "color curve" screens, for synthesis with "pure color" screens. With respect to the character of negatives required for color print synthesis, he made exactly the same theoretic mistake as Collen. He assumed that the opacities in each negative employed to make color prints should represent two of the color elements instead of one only; but, instead of superposing two single element negatives, he proposed to allow two color elements to act together in producing each negative.‡ For instance, he would allow both the blue and the yellow to act in the production of the negative for making red prints. The *principle* is exactly the same as that enunciated by Collen, and has the same fatal defect. Du Hauron himself saw that two color elements could not be fully represented in a single negative in their relation to the whites and grays, but declared that in practice the defect was not as great as would naturally be expected, and made an ingenious but wholly inadequate argument to explain away the difficulty.

No amount of argument can nullify a fact.

It has been asserted that Du Hauron's "binary" spectrum colors in reality correspond to the true "primaries," the descriptive term and not the colors themselves being erroneous. Writers who have made this assertion imply that I have misunderstood and misrepresented Du Hauron's work, but they are mistaken. Du Hauron not only plainly specified the "sifting of the rays of the two other colors," in contradistinction to exclusive sifting of the simple colors, but he distinctly said that *yellow and blue objects* must act alike (and as white) through the "green" screen, and while admitting that a cobalt blue glass is better than a "violet"‡ one for the blue-red negative, he adds that "there is here presented a physical fact not in accord with the theory."

This error of Collen and Du Hauron dies very hard, and is perpetuated with supreme assurance by new writers every little while.

One fact which must not be ignored is that, although Du Hauron's theory that the printing colors should correspond to his idea of the primary spectrum colors, red, yellow, and blue, the colors which he actually recommended are not *very* far removed from the *minus* colors of the true "primaries." His blue (Prussian blue) is a greenish blue; his red (carmine) is a crimson red; and his yellow is a *minus* blue. The fact is, that sheer experience led him to depart very considerably in the right direction from the requirements fixed by his theories; but his conclusion, most positively stated, that the photographs for positive synthesis should be made by "exclusive passage of the single color corresponding," while the photographs for negative synthesis should be made by "rays of the two other colors," is proof positive that he utterly failed to grasp the true relation between the two kinds of synthesis —the *plus* and *minus* character of the synthesis colors themselves—which certainly demands *identical* color records for both purposes, and also that they shall be "single element," "color curve" records.

Du Hauron's most important new contribution to the development of trichromatic photography at this period was his suggestion of a photochromoscopic device, of which I shall speak in another part of my lecture.

This may seem scant treatment of Du Hauron's early exploitation of the principles of trichromatic photography, in view of the fact that many people have regarded his early writings as the fountain head of this science; but I must take the facts as I find them, and his more or less natural errors do not in any way detract from my admiration of his prophetic spirit, and ingenuity, and fertility of imagination, which should be an inspiration to everybody who can read his original treatise on trichromatic photography.

Du Hauron's first patent application was dated November 23, 1868, but his first printed publication appeared in Le Gers, March 11, 13, 16, 18, 20, 23, and April 1 and 6, 1869, and shortly afterward in pamphlet form. According to his brother, Alcide Ducos du Hauron, he had communicated his ideas very fully,

* "Experiments on the prismatic spectrum show that all the colors of the spectrum, and all the colors in nature, are equivalent to mixtures of three colors of the spectrum itself, namely, red, green (near the line *E*), and blue (near the line *G*).

"The speaker, assuming red, green, and blue as primary colors, then exhibited them on a screen by means of three magic lanterns, before which were three glass troughs containing respectively sulphocyanide of iron, chloride of copper, and ammoniated copper.

"A triangle was thus illuminated, so that the pure colors appeared at its angles, while the rest of the triangle contained the various mixtures of the colors, as in Young's triangle of color.

"The graduated intensity of the primary colors in different parts of the spectrum was exhibited by the colored images, which, when superposed on the screen, gave an artificial representation of the spectrum.

"Three photographs of a colored ribbon, taken through the three colored solutions respectively, were introduced into the lantern, giving images representing the red, the green, and the blue parts separately, as they would be seen by Young's three sets of nerves separately. When these were superposed, a colored image was seen which, if the red and green images had been as fully photographed as the blue, would have been a truly colored image of the ribbon. By finding photographic materials more sensitive to the less refrangible rays, the representation of the colors of objects might be greatly improved."

* "When the reader has read this book entirely through, he will recognize that, in the method described in Chapter IV., and which constitutes the direct method (for the positive synthesis) . . . each of these images is obtained by the exclusive passage, or sifting of the rays of the simple color corresponding, through a space of the same color. Proceedings are not the same for the method of invasion" (for color print synthesis).—From Louis Ducos du Hauron's Treatise of 1869.

† "Each of the images, instead of being obtained by a sifting of the rays of the corresponding simple color through a space of that color, is obtained by a sifting of the rays of the two other colors through a space of the double color complementary to its own."—Du Hauron in 1869.

‡ He describes "violet" as a color containing a large portion of red, showing that he means purple, which is called for by his theory.

except in the matter of negative synthesis, in a memoire transmitted to a French scientist and Member of the Institute, M. Lélut, July 14, 1862. It is a curious fact that this memoire, said to have been intended for formal presentation to the Institute, but which was not published until 1897,* discloses several important ideas which are not to be found in any of Louis Ducos du Hauron's writings which were published prior to 1897, and which had meanwhile been published or patented by others. I shall have occasion to refer to this memoire again.

(To be continued.)

THE NEW BRIDGE ACROSS THE RHINE AT DUSSELDORF.

SINCE the building of the first iron bridge, in England, about one hundred and twenty years ago, great strides have been taken by the builders of such structures, as one will realize when looking at the accompanying engraving of the new bridge across the Rhine at Düsseldorf, which was erected by the Gutehoffnungs Works, near Oberhausen, and was opened with suitable ceremonies on November 12, 1900.

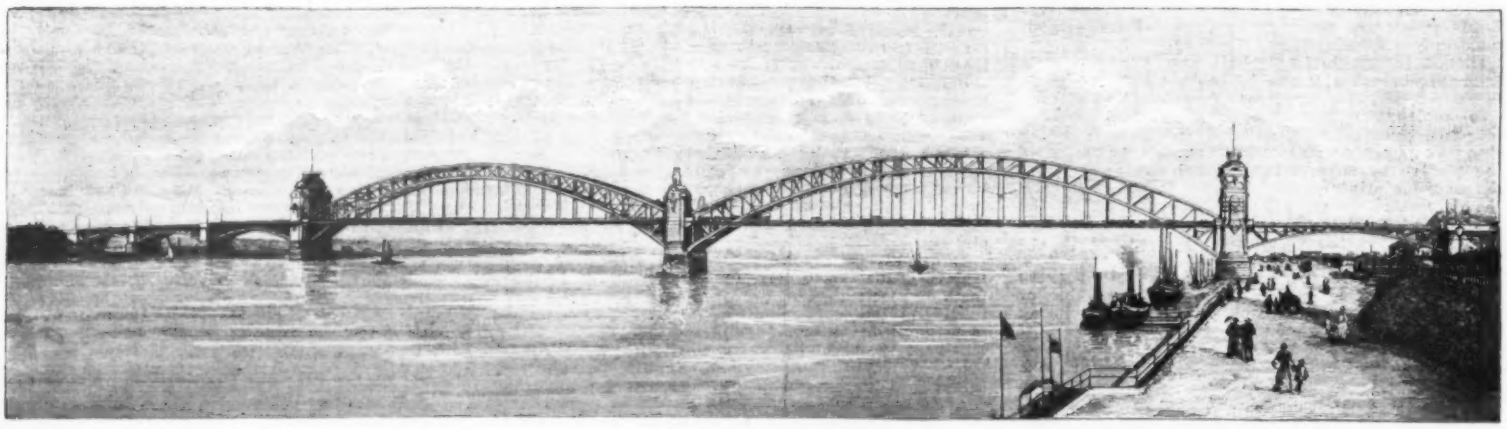
There was a railroad bridge near Düsseldorf, and a floating bridge served for the comparatively small number of foot passengers and wagons that needed to cross the river at this point, but about three years ago a company was formed for the purpose of building a bridge and also an electric road between Düsseldorf and Crefeld, which, it was thought, would open up the land on the left bank of the river, and this, together with the improvements of the banks themselves, the clearing of the waterway by the removal of the old floating bridge, and the improved arrangements for carrying off the water at high tide, would prove most advantageous to the State as well as to the public. By the removal of a high-water dam a large tract of land was recovered, and the sale of this land as building lots will cover a large part of the cost of the structure. The company has been allowed to levy toll, and as the traffic will certainly increase with the opening of the land on the left shore, an increase of the receipts may be confidently looked for. The bridge, without approaches, etc., cost about $1,071,000, but the expenditure of this amount has procured for the city not only a bridge which is most useful and gives every promise of lasting for centuries, but also a structure which is rich in architectural beauty and adds greatly to the appearance of the city. Beauty and fitness have been most happily combined by Prof. Reinhold Krohn, director of the bridge-building department of the Gutehoffnungs Works, who drew the plans for the bridge, as well as those for the bridge across the Rhine at Bonn, receiving a prize for the latter.

The Düsseldorf bridge has three piers, between which are two large arches 393 feet 9 inches long and rising to a height of 77 feet above the roadway. Each end pier supports a heavy portal built in the Renaissance style from designs drawn by Prof. Schill, of the Düsseldorf Academy of Art, and for which a prize was awarded him. On the central prier there is a gigantic lion holding an anchor and a coat-of-arms. At the left of the two long spans are three short spans, which are 206 feet 8 inches, 187 feet and 164 feet in length respectively. At the right there is one short span which is 196 feet 10 inches long, and extends over the river street of Düsseldorf. The total length of the bridge is about 1,948 feet, and the width 46 feet 6 inches, of which 26 feet 10 inches are devoted to the driveway, leaving 19 feet 8 inches for the use of pedestrians. Three million five hundred and twenty thousand pounds of iron were used in the construction of each of the long arches, and in building the entire structure 11,165,000 pounds of so-called ingot iron were employed. The use of this material permitted the construction of the long arches and made it possible to give the bridge the desired appearance of lightness, because the high breaking strain of iron of this kind admits of the use of thinner rods, etc.

Work on the piers was begun late in the summer of 1896 by the firm of Ph. Holzmann & Co., of Frankfort on the Main, who had their work so nearly completed by the spring of 1897 that the iron work for the left arch was then begun. Great difficulty and considerable danger were encountered in building the arch at the right. An opening 164 feet wide was left for the passage of all lines of tow boats and other vessels, but very soon after the opening had been bridged over with great girders made of wood and iron, a series of accidents occurred, caused by vessels running into the structure. The work had to be given up temporarily, as the collapse of the entire scaffolding was feared, but energetic steps were taken by which an extensive system of outlook and signal service was introduced, and after that the work on the right arch was completed in the short space of six weeks.

This new structure is certainly a fine example of modern bridge building, of which Germany may well be proud.—Illustrirte Zeitung.

* "La Triplice Photographique des Couleurs et l'imprimerie." Alcide Ducos du Hauron, Paris, 1897, p. 450.



THE NEW BRIDGE ACROSS THE RHINE AT DUSSELDORF.—BUILT BY PROF. REINHOLD KROHN.

NEW RAILWAY IN BRITISH COLUMBIA.

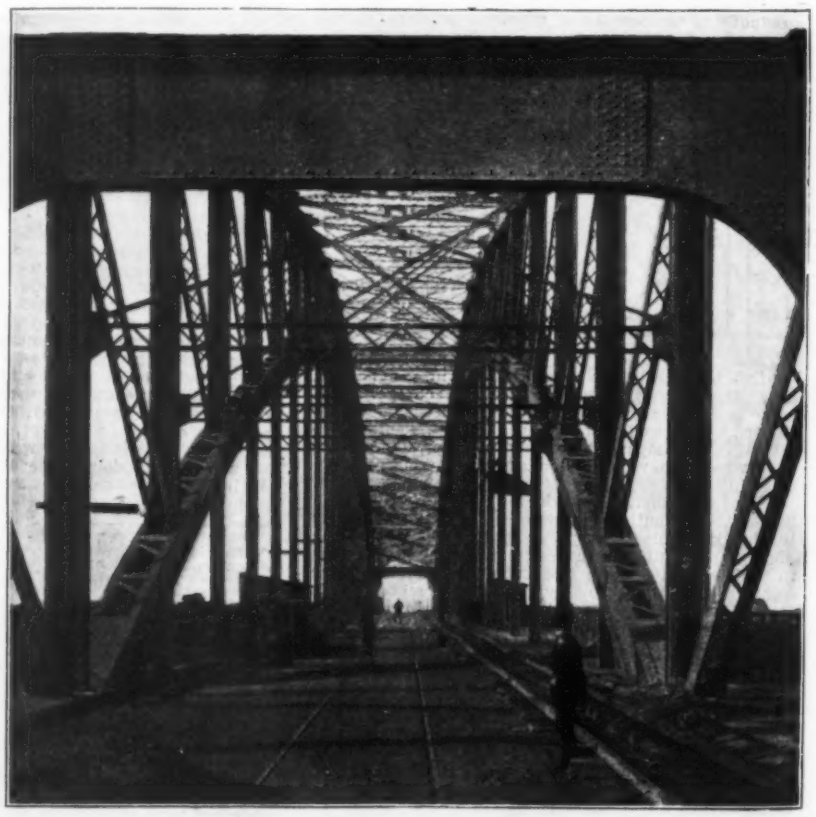
THE ratepayers of Victoria voted on November 29, 1900, to give a bonus of $15,000 per annum for twenty years to a syndicate which proposes to organize a railway and ferry to connect Victoria with the Frazer River Valley and the Great Northern Railway of the United States.

The company intends to construct a railway from the present terminus of the Victoria and Sidney Railway in this city through the streets to the terminus of the Esquimalt and Nanaimo Railway; to lease and use the Victoria and Sidney Railway for running cars to Sidney (18 miles away on the east coast of Vancouver Island); also to maintain a car-ferry service between Sidney, across the Gulf of Georgia, to Steveston, the great cannery town on the Frazer River; thence to build a railway to Cloverdale, British Columbia (26 miles), where connection will be made with the Great Northern Railway.

In addition to the bonus of $300,000, payable in twenty annual installments of $15,000 each, the syndicate has the privilege of using free of charge such streets of Victoria as are necessary to construct the 1¼ miles of track between the present railway depots; also, the use for twenty-five years at the nominal rental of $100 per annum of the city market building, now used by the fire department.

The distance between Sidney and Steveston, to be covered by a car ferryboat, is 45 miles, which it is expected will be traveled in less than three hours; the proviso being that the ferry steamship shall be capable of making 14 knots an hour and of carrying eight loaded freight cars, of the capacity of 30,000 pounds each, and four hundred passengers on each trip.

PORTAL OF THE NEW BRIDGE NEAR DÜSSELDORF.



VIEW OF THE IRON WORK OF THE NEW BRIDGE NEAR DUSSELDORF.

The Great Northern Railway has a five-year contract to carry all freight to and from Victoria by this route, which will enable cars to come direct to this city without breaking bulk, thus avoiding wharf charges for freight and transshipment of passengers.

The proposed line renders available the present Victoria and Sidney Railway, long one of the dead assets of the city, which pays each year $9,000 guaranteed interest on bonds of said road. By many, this is regarded as the commencement of an era of improvement which will culminate in the extension of the Esquimalt and Nanaimo Railway to Hardy's Bay, the extreme north of Vancouver Island, and thus place Victoria in the direct line of travel from the United States to the north.

No opposition is anticipated to the granting of a charter for the proposed new terminal railroad and ferry route, which, it is provided, shall be completed within two years and work on which, it is promised, will commence in the near future. But no active steps have yet been taken.—ABRAHAM E. SMITH, Consul at Victoria.

A NEW SOUNDING APPARATUS.

SOUNDING apparatus, even outside of those used in exploring expeditions, in which detailed and accurate studies of the ocean bottom are made, need to be sufficiently perfect to give results that can be relied upon. Often, in fact, and especially in the case of a fog, navigation has nothing but soundings as a guide in very dangerous quarters. In such a case, recourse is had to the time-honored sounding line, at the end of which is fixed a piece of lead in the shape of a truncated cone. In order that the length of line paid out at the moment that the lead touches bottom shall correspond exactly to the depth of the water at the point where the sounding is being done the line itself must be vertical. Now, this is something that can occur only exceptionally, even when the boat from which the line is thrown is at a standstill, and that can never occur when the boat is in motion.

For soundings that may be called scientific, numerous very remarkable instruments have been invented, descriptions of some of which have recently been given by Mr. Charles Bright, in Engineering; but, for ordinary practice, there are required simple and strong apparatus that can be put into the hands of any one and that occupy but little space. From this point of view it is of interest to make known a new sounding apparatus which is due to Messrs. Cooper and Wigzell, and which is based upon the principle of hydrostatic pressure, that is to say, it necessarily indicates, with accuracy, the height of the column of water that exists at the point of immersion of the instrument. The apparatus consists of several parts: In the first place, of a small windlass, which is installed upon the deck of the vessel, as shown in the accompanying engraving, in the second of a sounding line to which is attached a protecting case analogous to that of a medical thermometer, only on a larger scale, and, finally, of a sounding lead hollowed out to receive some tallow and attached to a long line.

The essential part is the sounding lead properly so called, of which an external view is given in Fig. 1, No. 2. Let us say at the outset that the graduation is such as to allow of measuring depths of 600 feet. This suffices, since it is a question here of an apparatus designed for use in ordinary navigation and not for scientific researches. It may be remarked that there are two graduations provided, one of which is for slight depths of from 0 to 20 fathoms. This is marked upon the left side of the tube, while the other is marked upon the right. We pass from one scale to the other by revolving a thumb-screw placed beneath. Moreover, the maximum depth reached during a sounding is indicated by a traveler.

Upon examining the interior of the apparatus as shown in the figure, we see that it is provided at its lower part with a spiral spring fixed to a vertical bar of which each face is toothed, and at the upper part of which is a piston that moves within a cylinder. Upon the bar itself there is a spring marker that engages with the teeth on each side of the bar. When this indicator is pressed downward, it ceases to engage with the teeth and may then be freely brought to zero. It may likewise be set at liberty automatically when the pressure of the water causes the piston to rise in the cylinder during the descent of the apparatus. After each sounding it therefore suffices to withdraw the "sounder" from its tube to read the depth indicated by the traveler, and finally to bring the latter to zero for a succeeding operation.

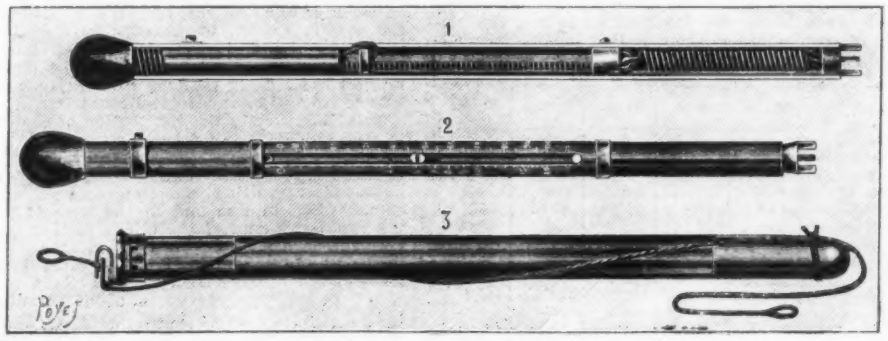


FIG. 1.—NEW SOUNDING APPARATUS.

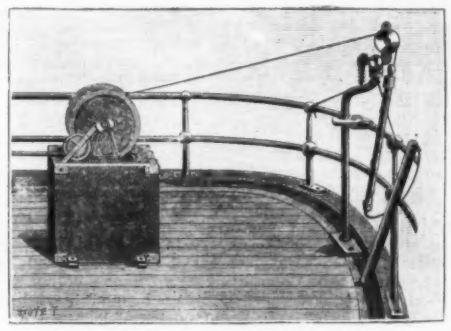


FIG. 2.—THE WINDLASS.

Of the windlass around which the line winds we shall not have much to say, inasmuch as it might, at a pinch, be done away with altogether. There are two kinds of this apparatus—one a very simple affair of cast iron, and another more complicated that may be dismounted and put under shelter when there is no occasion to use it. Both are provided with a brake that permits of controlling the speed at which the line unwinds. The most improved include a revolution counter that shows the length of cable paid out. The apparatus are carefully gaged according to the indications of a hydraulic pump, which has itself been submitted to mathematical experiments.

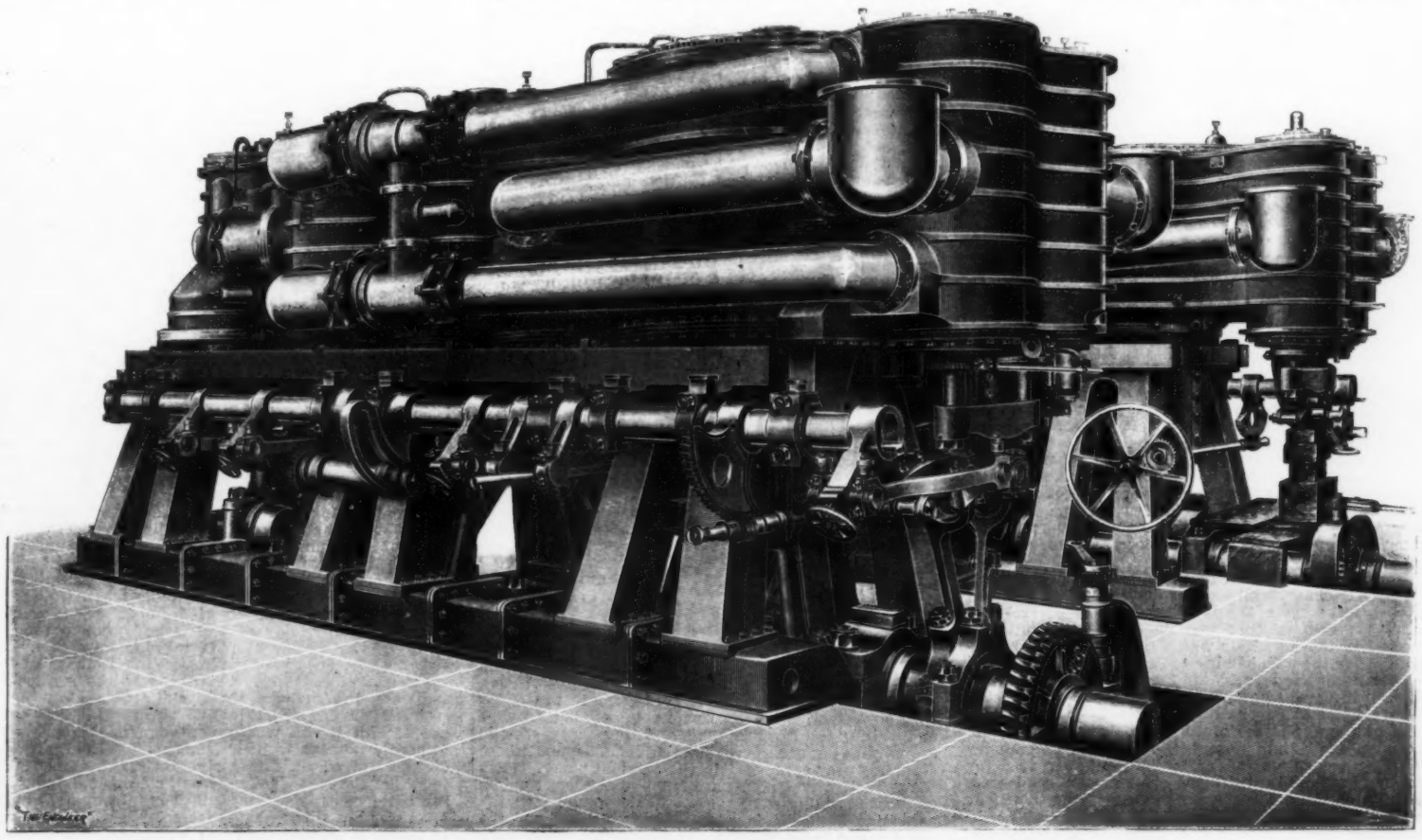
For the above particulars and the illustrations we are indebted to La Nature.

TRIPLE-EXPANSION ENGINES OF THE FRENCH CRUISER "KLEBER."

WE illustrate, says The Engineer, to which we are indebted for the engraving and description, one set of engines of the French cruiser "Kléber" exhibited at Paris by the makers, Schneider & Company, Le Creusot. The "Kléber" is fitted with three screws and three independent sets of engines, with a collective power of 17,000 indicated horse power. Each set consists of three cylinders. The valves are all of the piston type. The high-pressure has one, the intermediate-pressure cylinder has two, and the low-pressure cylinder three. The valve gear is Stephenson's. The cylinders are 34 inches, 48 inches, 77 inches by 31½ inches. At full speed the engines make 150 revolutions per minute. Steam is supplied by twenty Niclausse boilers, divided into four groups, two forward and two aft of the engine-room. The pressure is 256 pounds per square inch. The total grate surface is 1,100 square feet, the total heating surface, 35,500 square feet. The total weight of engines, boilers, etc., is 1,275 tons, water in the boilers included, which gives a total weight of 174 pounds per indicated horse power. The engines weigh 663 tons, and the boilers 612 tons. The total heating surface, omitting fractions, is two square feet per indicated horse power.

THE LAC INDUSTRY OF ASSAM.

A RECENT report of the Assistant Director of Agriculture in Assam deals in detail with the lac industry there. Lac occurs in its natural state in various parts of the forests of Assam, as well as of Burma, but chiefly in parts of the Khasi and Garo Hills, and the export in recent years has averaged 16,000 maunds, or something over 500 tons, but in some of the forests, owing to the ravages of the Kolaazar epidemic and depopulation, the production is declining. The production in Manipur is not sufficient for the local needs, and quantities of the lac are sent there from the Kubo Valley of Assam. The lac is all sent away from Assam in the crude



TRIPLE-EXPANSION ENGINES OF THE FRENCH CRUISER "KLEBER."

form, or stick lac; shell and button lac are made, to some extent, but lac dye is not now prepared anywhere in Assam, and lacquer wares are only produced in two places, so that this once considerable industry would seem to be dying out. The black lacquer of Manipur is really not a lac preparation at all, but only the juice of a tree sent from the Kubo Valley. In Assam the lac is usually collected twice a year, first in May and June, and then in October and November. The first is mainly used for seed purposes, while the second forms the export. A few days after the collection, pieces of stick lac containing living insects are tied on to the branches of the trees on which the next crop is to be grown. The usual plan is to place the lac in small bamboo baskets and tie these on the twigs of the trees. The insects soon crawl out, and spread over the young branches, on which they promptly begin to feed, and secrete the resin. This is allowed to go on for about six months, when the lac is collected; but if the secretion has been defective or insufficient, the insects remain undisturbed for another six months.

EXPLOSION OF POTASSIUM CHLORATE.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In a late issue, January 5, of the SUPPLEMENT there appears an article on the "Explosion of Potassium Chlorate."

As stated, the salt explodes readily in a hydrocarbon flame, either a common lamp or a Bunsen flame producing the decomposition.

The experiment is very instructive and may be used with advantage before elementary classes when studying the artificial production of oxygen by the decomposition of a mixture of $KClO_3$ and MnO_2.

The experiment is best performed as follows: A small loop of platinum wire, such as is used in blowpipe analysis, is loaded with a crystal of the salt. This is then introduced into the center of a Bunsen flame and gradually fused by raising it into the upper part of the inner cone. Here the exact conditions obtain which are provided in the more elaborate experiment, namely, a temperature higher than the commencing of the decomposition. If now the bead is lifted into the hottest part of the flame, the explosion will take place as described. It is essential that the salt be entirely fused, else the explosion will be retarded and preceded by a sputtering of smaller explosions.

The great advantage in performing the experiment after this fashion arises from the fact that the explosion can be more carefully studied. After the decomposition a film of KCl will be found over the platinum loop.

The experiment is valuable in that it illustrates the dissociating effects of heat in general, and also indirectly the modifying effects of MnO_2 in the production of oxygen by our common methods.

WILLIAM A. DAVIES,
Of Denison University.

ARGON AND ITS COMPANIONS.*

THE discovery of krypton and neon was announced to the Royal Society in the early summer of 1898; and subsequently atmospheric air was found to contain a heavier gas to which the name of xenon was applied. Mr. Baly, in the autumn of the same year, called attention to the presence of helium lines in the spectrum of neon, an observation which confirms that made by Prof. Kayser, of Bonn, and by Dr. Friedländer, of Berlin.

At the same time we imagined that we had obtained a gas with a spectrum differing from that of argon and yet of approximately the same density; to this gas we gave the name metargon. It has now been found that the presence of the so-called metargon is to be accounted for by the fact that in removing oxygen from the mixture of these gases, which was then in our hands, phosphorus containing carbon was employed; this mixture when burned in oxygen yields a spectrum to some extent identical with that furnished by carbon monoxide, but differing from it inasmuch as lines of cyanogen are also present. We have no doubt that the so-called metargon, the spectrum of which is visible only at high pressure, and only when impure phosphorus has been employed to remove oxygen, must be attributed to some carbon compound. In spite of numerous experiments we have not yet succeeded in producing any gas in quantity which yields this composite spectrum. It is only to be obtained by a mixture of carbon monoxide with cyanogen.

To obtain the heavier gases krypton and xenon, a large amount of air was allowed to evaporate quietly; the residue was freed from oxygen and nitrogen, and then consisted of a mixture of krypton, xenon, and argon, the last forming by far the largest portion of the gas; this mixture was liquefied by causing it to flow into a bulb immersed in liquid air, and the bulk of the argon was removed as soon as the temperature rose, the krypton and the xenon being left behind. By many repetitions of this process we were finally successful in separating these three gases from each other. While krypton has a considerable vapor-pressure at the temperature of boiling air, the vapor-pressure of xenon is hardly appreciable, and this afforded a means of finally separating these two gases from one another; in the complete paper the operations necessary to separate them are fully described.

For neon the process of preparation was different. The air liquefier furnished a supply of liquid air; the gas escaping from the liquefier consisted largely of nitrogen; this mixture was liquefied in a bulb immersed in the liquid air which the machine was making. When the bulb had been filled with liquid nitrogen a current of air was blown through the liquid until some of the gas had evaporated. That gas was collected separately, and deprived of oxygen by passage over red-hot copper; it contained the main portion of the neon and the helium present in the air. The remainder of the nitrogen was added to the liquid air used for cooling the bulb in which the nitrogen was condensed. Having obtained a considerable quantity of this light nitrogen it was purified from that gas in the usual manner, and the argon containing helium and neon was liquefied. By fractional distillation it was possible to remove the greater portion of the helium and neon from this mixture of gases, leaving the argon behind. Many attempts were made to separate the helium from the neon. Among these was fractional solution in oxygen, followed by a systematic diffusion of the two gases; but it was not found possible to raise the density of the neon beyond the number 9.16, and its spectrum still showed helium lines. It was not until liquid hydrogen, made by an apparatus designed and built by one of us (M. W. T.), had been produced in quantity, that the separation was effected; the neon was liquefied or perhaps solidified at a temperature of boiling hydrogen, while the helium remained gaseous. A few fractionations serve to produce pure neon; we did not attempt to separate the helium in a pure state from this mixture.

That these are all monatomic gases was proved by determination of the ratio of their specific heats by Kundt's method; the physical properties which we have determined are the refractivities, the densities and the compressibilities at two temperatures, and of argon, krypton, and xenon the vapor-pressures and the volumes of the liquids at their boiling points.

The results are as follows:

	Helium.	Neon.	Argon.	Krypton.	Xenon.
Refractivities (Air = 1) ...	0·1238	0·2345	0·968	1·449	2·364
Densities of Gases (O = 16)	1·98	9·97	19·96	40·88	64
Boiling-points at 760 mm.	?	?	86·9° abs.	121·33° abs.	163·9° abs.
Critical temperatures ...	?	below 68° abs.	155·6° abs.	210·5° abs.	287·7° abs.
Critical pressures	?	?	40·2 metres	41·24 metres	43·5 metres
Vapour-pressure ratio ...	?	?	0·0350	0·0467	0·0675
Weight of 1 c.c. of liquid	?	?	1·212 grammes	2·155 grammes	3·52 grammes
Molecular volumes	?	?	32·92	37·84	36·40

The compressibilities of these gases also show interesting features. They were measured at two temperatures—11.2 degrees and 237.3 degrees; the value of P.V. for an ideal and perfect gas at 11.2 degrees is 17,710 meter-cubic-centimeters, and at 237.3 degrees to 31,800. This is, of course, on the assumption that the product remains constant whatever be the variation in pressure. Now with hydrogen at 11.2 deg. C. the product increases with the rise of pressure; with nitrogen, according to Amagat, it first decreases slightly and then increases slightly. With helium the increase is more rapid than with hydrogen; with argon there is first a considerable decrease followed at very high pressures by a gentle increase, although the product does not reach the theoretical value at 100 atmospheres pressure; with krypton the change with rise of pressure is a still more marked decrease, and with xenon the decrease is very sudden. At the higher temperature the results are more difficult to interpret; while nitrogen maintains its nearly constant value for P.V., helium decreases rapidly, then increases, and the same peculiarity is to be remarked with the other gases, although they do not give the product of P.V. coinciding with that calculable by assuming that the increase of P.V. is proportional to the rise of absolute temperature.

These last experiments must be taken as merely preliminary; but they show that further research in this direction would be productive of interesting results.

The spectra of these gases have been accurately measured by Mr. E. C. C. Baly, with a Rowland's grating; the results of his measurements will shortly be published. It may be remarked, however, that the color of a neon-tube is extremely brilliant and of an orange-pink hue; it resembles nothing so much as a flame; and it is characterized by a multitude of intense orange and yellow lines; that of krypton is pale violet; and that of xenon is sky-blue. The paper contains plates showing the most brilliant lines of the visible spectrum.

That the gases form a series in the periodic table, between that of fluorine and that of sodium, is proved by three lines of argument:

(1) The ratio betwen their specific heats at constant pressure and constant volume is 1.66.

(2) If the densities be regarded as identical with the atomic weights, as in the case with diatomic gases such as hydrogen, oxygen, and nitrogen, there is no place for these elements in the periodic table. The group of elements which includes them is:

Hydrogen. 1	Helium. 4	Lithium. 7	Beryllium. 9
Fluorine. 18	Neon. 20	Sodium. 23	Magnesium. 24
Chlorine. 35·5	Argon. 40	Potassium. 39	Calcium. 40
Bromine. 80	Krypton. 82	Rubidium. 85	Strontium. 87
Iodine. 127	Xenon. 128	Cæsium. 133	Barium. 137

(For arguments in favor of placing hydrogen at the head of the fluorine group of elements, see Orme Masson, Chem. News, vol. lxxiii., 1896, page 283.)

(3) These elements exhibit gradations in properties such as refractive index, atomic volume, melting-point and boiling-point, which find a fitting place on diagrams showing such periodic relations. Some of these diagrams are reproduced in the original paper. Thus the refractive equivalents are found at the lower apices of the descending curves; the atomic volumes, on the ascending branches, in appropriate positions; and the melting and boiling-points, like the refractivities, occupy positions at the lower apices.

Although, however, such regularity is to be noticed, similar to that which is found with other elements, we had entertained hopes that the simple nature of the molecules of the inactive gases might have thrown light on the puzzling incongruities of the periodic table. That hope has been disappointed. We have not been able to predict accurately any one of the properties of one of these gases from a knowledge of those of the others; an approximate guess is all that can be made. The conundrum of the periodic table has yet to be solved.

MAMMALS AND REPTILES; OR, WHAT WAS THE ICE AGE?

By JOSHUA RUTLAND.

THE largest existing species of mammals and reptiles are aquatic, many of them being especially adapted to the water and unable to exist on land; thus the great Cetacea head the former, the crocodile and sea-turtle the latter division of the animal kingdom. If from this seeming anomaly among air-breathing animals we turn to the geographical distribution of the aquatic species, we discover an important difference. To the cold seas of the high latitudes the large Cetacea chiefly belong, while the large aquatic reptiles are strictly confined to the rivers, lakes and seas of tropical or sub-tropical countries.

This difference in the distribution of the two orders is not limited to the aquatic species, for we find it even more pronounced when terrestrial species are examined. Proceeding from the equator toward the poles, after quitting the tropics, reptiles diminish rapidly both in size and in the number of species, the reptilian fauna of the colder portion of the temperate zone being comparatively meager. Within the Arctic Circle the order is represented by a single species, the common British frog, Rana temporaria, which in Norway ranges to about seventy degrees north. On the other hand, many large mammals such as the polar bear, musk ox, and reindeer, are permanent inhabitants of the north frigid zone, the mammalian fauna of the adjacent temperate zone being very numerous and extremely varied. This difference in the geographical distribution clearly denotes a difference between warm and cold blooded air-breathing animals, a conclusion which is further strengthened when the distribution and habits of birds are taken into account. A few birds winter within the Arctic Circle, and many resort there or migrate from low to high latitudes during the breeding season, proving that the summer temperature of the warmer zones is unfavorable to their increase.

Turning now to the portion of the earth's history gathered from geological sources:

During what has been termed the reptilian period, reptiles larger than any existing species inhabited the seas of the temperate zone. In Spitzbergen and in the New Zealand archipelago sedimentary rocks of marine origin contain numerous remains of the ichthyosaurus and plesiosaurus, animals adapted to the ocean like the cetacean of the present day. Associated with these remains are large mollusca, corals and other organisms now restricted to tropical seas.

While these great saurians dominated the ocean other reptiles were as widely distributed on land, occupying places now monopolized by warm-blooded animals. Huge pterodactyls traversed the air like birds, and the unwieldy iguanodon fed upon the herbage like our modern ruminants.

From the same geological sources we learn that Greenland had formerly a generous vegetation, the remains of plants resembling the Sequioæ, magnolias and laurels of the New World being found embedded in the rocks of that now inhospitable clime. In the New Siberian Islands a seam of bituminous coal proves that dreary region was once clothed with verdure, while fossil plants akin to palms and pandanus grew in England and on the adjacent continent, showing that the flora of Northern Europe had at some time what we would now term a tropical aspect.

The most important facts in the history of the Tertiary period are the decrease of reptiles and the increase of mammals. At the commencement of the period, before the great marine saurians finally disappeared, the fauna of Europe included many arboreal mammals of types now confined to the tropical regions of the Old and New World. Toward the middle of the period swift-footed herbivora resembling the antelopes of Africa became numerous, and these as the period drew to a close gave place to forms still found throughout the north temperate zone.

During the Ice Age immediately after the close of the Tertiary period terrestrial mammals attained their greatest development; the mammoths and mastodons preserved in the frozen soil of Siberia and Northern America surpassed in bulk all existing species. To the commencement of this rigorous period the first positive traces of man must also be assigned.

Since the passing away of the glacial cold, besides the mammoths and mastodons, several large mammals such as the cave bear, woolly rhinoceros, which existed contemporaneously with primitive man, have disappeared, and others like the reindeer, which during the Ice Age ranged into Southern France, have altered their habitat, but no great change in the general character of the fauna analogous to the displacement of reptiles and mammals has taken place.

In considering the great climatic changes above referred to, we must first determine whether the ice age was really a distinct period due to special causes or merely the climax of a long and gradual cooling down of the earth's climate taken as a whole. In either case the present climatic condition must be the result of causes in some measure the reverse of those which brought on the glacial cold.

The limited distribution of aquatic reptiles compared with the distribution of aquatic mammals is evidently not due to their being unable to cross wide expanses of ocean, for marine turtles are frequently found on the New Zealand coast, a large specimen being quite recently captured in Tory Channel (Middle Island). Yet turtles have not established themselves in the New Zealand seas. As water snakes and other marine reptiles are also found far outside their proper

* A paper by Prof. William Ramsay, F.R.S., and Dr. Morris W. Travers. Read at the Royal Society on November 15, 1900. Abstract in Nature.

latitudinal range, in the absence of any other adequate cause we must conclude that these animals are unable to adapt themselves to the colder water of the temperate zone, hence their restricted diffusion. Unless the great pelagic reptiles of the secondary geological period were constitutionally different from the modern marine reptilia, the general temperature of the ocean when they existed must have been far higher than it is at present, for the presence of their remains in the northern and southern hemispheres denotes a distribution which could not have been due to any local increase of heat.

If the mean temperature of the ocean was high, it is evident from the effects of the Gulf Stream and other oceanic currents that the mean temperature of the atmosphere must have been correspondingly high, a condition necessary to account for the extraordinary development and distribution of terrestrial reptiles when the great saurians occupied the deep.

Reptiles attained their maximum development during the Mesozoic period, but to discover their advent we must go back to the preceding Palæozoic era, when the order was represented by amphibians, a group of animals having much in common with fishes—the dominant or characteristic order of the Carboniferous and Devonian sub-periods. In like manner, though mammals especially characterize the Tertiary and subsequent periods their history extends far back into the age of reptiles, which might also be designated the age of marsupials. It was at that time the lowest subdivision of the mammalia was most widely distributed.

At present marsupials are confined to the warm portion of the New World—where about twenty species, all belonging to the family Didelphis, exist—to Indonesia and to Australia, including New Guinea and Tasmania. In Australia marsupials still characterize the fauna, filling places elsewhere occupied by placenta, carnivora, herbivora, insectivora and rodents. The peculiarities of the Australian fauna are generally attributed to an isolation which some writers date back to Mesozoic times, but excepting the absence of placental mammals the production of the region taken as a whole corresponds with the rest of the world. The flora is an assemblage of dicotyledons, monocotyledons and cryptogams; among the birds the raptores, scansores, volitores, cantores, rasores, crallatores, natatores and cursores are all well represented. The numerous reptiles are even less distinctive than the birds, being all of the modern types—crocodilia, orphidia, lacertilia, chelonia and batrachia.

If the fierce Carnivora, well-armed ruminants and powerful Omnivora in the neighboring Asiatic regions had access to Australia, the comparatively defenseless marsupials would have disappeared or would have been reduced to a few species capable of maintaining their existence by concealment or flight. The isolation which enabled the warm-blooded marsupials to survive through the Tertiary period down to our own times did not preserve a single species of their ancient contemporaries, the reptiles of the Mesozoic era; we must therefore conclude that the extinction of these cold-blooded animals was due to causes against which even ocean barriers were ineffective.

The great gap in the geological history of the northern hemisphere between the Cretaceous and Eocene periods has left us ignorant of how the Mesozoic fauna and flora passed into the fauna and flora of the succeeding Tertiary era. From widely separate sources such as the Maestricht beds, rocks at Aix-la-Chapelle and the Cretaceo-Tertiary formation of New Zealand, which may be compared to the scattered leaves of a lost volume, we learn that before the great pelagic saurians disappeared, dicotyledonous plants were universally distributed. Among the fossils discovered at Aix-la-Chapelle are the remains of plants resembling the oak, walnut and fig, now characteristic of the European region, intermingled with remains that have been referred to the order Protaceæ now largely represented in Australia. Evidently before the age of reptiles finally closed the earth or a great portion of it was clothed with the same assemblage of cryptogams, monocotyledons and dicotyledons which everywhere now prevails. Though these three forms of vegetable life are universally dispersed in the distribution of the arborescent species, there is a marked difference, dicotyledonous trees ranging into much higher latitudes than aborescent monocotyledons or tree ferns, the only cryptogams which at present attain tree-like dimensions.

Since the commencement of the Tertiary period cetaceans have been the largest denizens of the deep. From Eocene deposits of the United States whole skeletons of a zeuglodon about seventy feet in length have been recovered. The Cetacea naturally fall into two divisions, the toothed whales and the Balænidæ, from which whalebone is obtained; to the former division the zeuglodons belong, no traces of the Balænidæ have been discovered in rocks older than the Miocene period, when the group was represented by species from two to ten feet long. At present toothed whales are found in all seas from within the Arctic to within the Antarctic circles, but the largest existing species, the sperm whale, is mostly confined to the warm seas of low latitudes; on the other hand, the largest representatives of the Balænidæ, the right whale as they are popularly styled, belong strictly, in both hemispheres, to the polar and adjacent seas. The Procidæ, like the Cetacea, are found in every zone, but more especially in the cold seas of temperate and polar regions. The largest species, the sea-elephants of the southern hemisphere and the Arctic walrus, are confined to high latitudes. Carnivora were numerous in Eocene times, but no traces of the extremely specialized pinnigrade have been discovered in deposits older than Pliocene, their remains being most abundant in Quaternary and recent formations. The Ungulates like the cetaceans take us back to the earliest Tertiary times, when both Perissodactyla and Artiodactyla were already well represented. The modification of the ancient Eocene types into the highly specialized animals of the present day can only be accounted for by changes in the environment, compelling adaptation by natural selection. From two such distinct lines the Perissodactyla and Artiodactyla, culminating in swift forms like the various species of Equus and the antelopes, deers, etc., especially adapted to open pastures, we must conclude that the causes had been long in operation and were general in their effects.

From the Eocene deposits of England, France and other parts of Europe, remains of several species of Palæotherium have been obtained. Some of these animals which resembled the modern tapir, having like it a short prehensile trunk, were about the size of a horse and inhabited marshy ground, being partly aquatic in their habits. The tapirs, of which there are four or five species, belong exclusively to the warm regions of the Old and New Worlds, a distribution characteristic of mammals that can be referred to very ancient types; thus the Lemuroidea, confined to Madagascar, Africa and Indonesia, are descended from animals distributed during the Eocene period over Europe and North America. The early Tertiary artiodactyles, of which the Chæropotamus is an example, were principally omnivora, a subdivision of the Ungulata, now reduced to the comparatively small family Suina, including some very distinct genera such as the wart hogs of Africa, the peccaries of America and the babyroussa of the Malay Archipelago. The Suina generally belongs to warm countries, but one species, Sus scrofa, or wild boar, ranges over the temperate portions of Europe and Asia and was formerly plentiful in the British Islands.

Of the true herbivora, which constitutes such a large proportion of existing faunas, we have no positive evidence before the Middle Tertiary period; since then the species have steadily increased until we find them occupying level plains and mountain heights within the torrid, temperate and frigid zones. Among the horned herbivora three distinct types can be recognized, antelopes and the hollow-horned and antlered ruminants; of these the antelopes are the most ancient, numerous remains of animals resembling the modern gazelles, gemsbok and koodoos occurring in the Miocene deposits of Europe, especially of Southern Europe. In the British Islands only one species, a gazelle, has been discovered, and none has been found on the American continents. The antelopes belong chiefly to warm latitudes and are especially characteristic of the African region, from whence between eighty and ninety species have been described. Asia possesses about fifteen species, mostly southern, though some range over the whole continent. Europe and North America have each two species, while in South America they are entirely wanting. The ruminants, including the buffaloes, bisons, oxen, sheep, goats and deer, are very widely distributed over both the eastern and western hemispheres. In the African region, to which more than four-fifths of the antelopes belong, only two species, Bubalus Caffer and B. brachyceros, are found, the deer, Cervus Dama and C. Elaphus, inhabiting the northern portion of the continent being most likely introduced during the Roman occupation. Herodotus, whose descriptions are generally reliable, says: "The stag and the wild boar are never seen in Lybya." Of the north temperate and Arctic zones, the ruminants are especially characteristic, the reindeer and moose being circumpolar in their ranges.

The earliest remains of the branched and hollow-horned herbivora have been discovered in European Pliocene deposits, but probably the simple horned Palæmeoryx of the Miocene period were the ancestors of our modern deer.

At the close of the Tertiary and throughout the Quaternary period ruminants, at least generically allied to existing species, must have been important features in the faunas of Eurasia and North America, judging by the abundance of their remains. As these generic types survived the glacial epoch, and many of the species along with other contemporaneous mammals moved into higher latitudes when the cold abated, we must conclude that they had become adapted to the rigorous climate, an effect which could only be brought about by a very gradual lowering of temperature. This conclusion is strengthened by the presence at the same time of the mammoth or woolly elephant and the woolly rhinoceros, which have disappeared since man became an inhabitant of the European era. Though in their distribution the two branches of the herbivora overlap, the ruminants or younger branch occupies decidedly the coldest portion of the region over which the family is dispersed. In the distribution of the herbivora and omnivora, one of the oldest branches of the Ungulata, and in the distribution of mammals and reptiles already sketched, we find an exactly similar arrangement, the older types being more restricted than the newer in their latitudinal range.

From the remains of plants and animals preserved in sedimentary rocks we infer the climatic conditions of the Tertiary and earlier geological periods, but the evidences of the ice age are more direct. In the British Islands, in New Zealand, on the mountains of Southern Europe and on the slopes of the Himalayas, from end to end of the American continent, in every quarter of the globe, there are traces of ice action on an extensive scale where no ice now accumulates. We have no means of determining in years when the building up of moraines, the grooving, polishing and transporting of rocks took place, but we can say with certainty these widely scattered remains all belong to a very recent geological period. Many animals that inhabited the Eurasian region during the ice age still exist, while others have become extinct, the most important being the reindeer and mammoth, both of which were contemporaneous with primitive man. Of all the large herbivorous mammals, the reindeer occupies the most dreary regions, subsisting on the scant vegetation of Greenland and the shores of the Arctic Ocean. Like its survivor the reindeer, the mammoth occupied the coldest portion of the northern hemisphere. The discovery of complete carcasses in the tundra of Siberia has familiarized us with the physical features, the habits and food of this unwieldy monster. After quoting in full a description given by M. Benkendorf, a Russian surveyor, who in 1846 had an opportunity of examining the carcass of a mammoth in the bed of the Indigirka, Mr. Boyd Dawkins in an article on the range of the mammoth continues: "This most graphic account affords a key for the solution of several problems hitherto unknown. It is clear that the animal must have been buried where it died, and that it was not transported from any place further up stream to the south, where the climate is comparatively temperate. The presence of fir in the stomach proves that it fed on the vegetation which is now found at the northern part of the woods as they join the low, desolate, treeless, moss-covered tundra in which the body lay buried—a fact that would necessarily involve the conclusion that the climate of Siberia in those ancient days differed but slightly from that of the present time."

During the ice age the reindeer and mammoth ranged as far south as Italy and the shores of the Caspian; associated with these were the northern glutton, the elk and the musk ox, still existing, but confined to high latitudes, and the cave bear, cave hyena, Rhinoceros hœmitœchus, that have passed away. There is nothing to indicate that previous to the glacial period this fauna was confined to a narrower or more northerly zone, or that during the Quaternary period there was any extraordinary change in the fauna of Eurasia, all the Quaternary mammals having their prototypes in animals that inhabited the region in the preceding periods.

From the warm covering of the reindeer and its moving southward in winter and returning to its northerly haunts in summer we may conclude that it essentially belongs to extremely cold climes and is not adapted for a warmer zone. The extinction of the reindeer south of the Baltic within historic times proves it was not as capable of maintaining itself as were the other species of hervus still inhabiting Northern Germany.

We learn from M. Benkendorf that unlike its almost naked relative Elephas Indicus the mammoth was clothed with a dense covering of hair and wool, plainly an adaptation to its inhospitable habitat; possibly it may have been migratory, which would account for its remains being discovered so far south. We know that the early inhabitants of Europe were acquainted with the mammoth and that they employed its tusks in their primitive arts. From this and the fact that is huge body being unfitted for concealment it has been concluded that the species was exterminated by man, but we may ask why were not the elephants that survive also exterminated? They are likewise bulky animals not very capable of concealment.

Knowing that the animals of the polar regions cannot be transplanted even into the warm portions of the temperate zone any more than the animals of the tropics can be transplanted to high latitudes, it seems more reasonable that the extinction of the mammoth and its numerous contemporaries was owing to their being constitutionally unfitted for a warm clime. The length of time that has elapsed since the disappearance of the glacial ice is not very great; its climatic change must therefore have been comparatively rapid, probably too rapid for the slow process of adaptation.

In the present Arctic and Sub-Arctic faunas we see the glacial fauna impoverished by the disappearance of many large characteristic species and with its domain reduced to a mere fragment of what it was originally. This is precisely what befell the reptilian fauna of Mesozoic times; its largest and most conspicuous members were eliminated and its domain curtailed; but while the glacial animals were drawn toward the poles, reptiles were driven toward the equator. Regarding the Arctic animals, we can say positively the disturbing cause was climatic; the abatement of the glacial cold compelled them to retreat northward, abandoning places where their remains are now found. In the case of the reptilia, the effect being so similar, we may reasonably conclude the disturbing cause was also climatic, but of a different nature. It is from cold regions reptiles have disappeared; to a cooling of the ocean and atmosphere the dying out of so many species and their limitation of range must be attributed.

The early Quaternary animals of Eurasia being so well adapted to the rigorous climate of the ice age, besides proving that the change of temperature was very gradual, shows that the species were capable of adaptation or variation in that particular direction. Throughout the Tertiary period the European mammalia underwent continuous modifications. The arborescent animals, the great omnivora and the tapir-like ungulate of Eocene times, gave place to animals better adapted for open country, to ruminants of the type which were ultimately displaced by modern forms. The only favorable explanation of these modifications is they were adaptations to changing conditions. To climatic alteration, to a general lowering of temperature, the displacement of the cold-blooded reptiles by warm-blooded mammals, which commenced in the Mesozoic period, is due; but this change did not cease when mammals came to the front. Like their reptilian predecessors, the European mammals of the early Tertiary epoch retired toward the equator and disappeared.

We cannot follow any slow change step by step through the geological record; a variation must be well pronounced before it can be recognized with certainty. All geologists agree that the climate of Europe was colder toward the close of the Pliocene period than it was during the preceding Miocene period. The evidences of the ice age are unmistakable; and the age of reptiles, its passing away, and the great changes that have taken place in the European mammals are distinctly recorded. From this evidence taken as a whole, and interpreting the past by the present, the only feasible reply to what was the ice age seems, that from the Mesozoic period onward there was a gradual cooling which culminated in the glacial cold and which was followed by an increase of temperature.

The causes of these climatic changes are not within the scope of this inquiry, but if the conclusions arrived at are correct they must at once account for the high temperatures of the ocean and atmosphere in early geologic times, for the gradual coming on of the glacial cold and for the return of a more genial climate.

RISK OF DISEASE FROM GARBAGE GATHERING.

THE Philadelphia Medical Journal says: "In all of our hygienic concern and progress it seems strange that, the world over, there is such great carelessness in the gathering and disposal of the refuse of city houses.

It is usually stored or rather dumped about cellars and back-yards for a reckless week, in which all the elements necessary to fermentation and putrefaction have ample time to ripen and dry. Then it is mixed and set out on the pavement for the winds to carry to the mouths and noses of all the inhabitants. If the wind happens to be at all active, the dumping into the wagons and carts soon fills the city with the clouds of dust. Then for miles the loose-jointed, over-filled wagons jostle over and scatter a large part of the contents along the streets, until at last, in dumping (perhaps down a long steep), the wind has another opportunity to send abroad all but the heaviest and least noxious portion of the load. Every city permits carpet-beating and rug-dusting, so that all tuberculous or other disease germs secure every possible chance to find a lodging place in the human throats and clothes, and, if once failing, they are beaten up and resown incessantly until the seed no longer falls upon barren ground. If the health of the community were only a tenth of the importance to our masters that the election of the boss is!"

STATE SALE OF ALCOHOL IN RUSSIA.

THE "regime" of alcoholic beverages underwent profound modifications during the course of the last century. Emperor Alexander III. especially endeavored to find a means of combating inebriety, which, during his reign, was, in the rural districts particularly, reaching alarming proportions. He had already, toward the end of his reign, substituted monopoly, or direct sale by the State, for the preceding regimes in thirty provinces. His son, Emperor Nicolas II., has rapidly extended this measure, which he considers as a work highly conducive to the spread of morality.

It is not for a fiscal object that this reform has been undertaken, the financial part of the question having been relegated to a second place. The State has occupied itself principally with exerting a beneficent influence upon the material and moral situation of the population. Monopoly, as it is understood in Russia, consists in suppressing all tap-rooms, and replacing them by retail stores analogous to the French "bureaux de tabac," but with the difference that, instead of getting a commission upon the products of the sale, the agent has a fixed salary, and therefore has no incentive to increase the consumption. The 0.18 of a franc bottles hold 6 centiliters. They must not be uncorked on the spot, but must be carried to the purchaser's own house for consumption. Besides, there are no sales on credit. The empty bottles are returnable at a certain price. There are now more than ninety millions of them in circulation in the provinces submitted to the monopoly. By suppressing tap-rooms, which were the principal places of debauchery and violence, the sale of alcohol of inferior quality, and often injurious, was also suppressed. Nevertheless, account has been taken of the utility of the tap-room in a certain measure as a place of reunion at which people can exchange ideas and discuss their interests, and so, as a substitute therefor, there have been provided as many temperance resorts as possible where are organized spectacles and reading and assembly rooms, and in which the use of alcoholic beverages is forbidden. From the reports addressed to the Emperor by the Governors of the provinces in which the monopoly is in operation, it is found that the effects of the reform have been very salutary. Drunkenness has sensibly diminished and crimes and misdemeanors have become more rare, while deposits at the savings banks have increased.

On another hand, as a consequence of the better quality of the products sold, and of the establishment of prices that are always uniform and proportionate to the quantity, a revenue has been obtained greater than that which was derived from the old taxes. The State has not monopolized the distillation of alcohol, but has merely limited and regulated it. It obtains by adjudication a third of the quantity necessary; the two other thirds are purchased from the producers of the region. It thus acquires the entire product, and reserves to itself the exclusive right to act as a middleman, so to speak, between the producer and consumer. The alcohol is preserved in government storehouses. It is rectified by the State in works of its own or under its immediate supervision, and is delivered to the public only in receptacles bearing the State seal and upon which are indicated the capacity and proof.

A special pavilion installed at the recent Exposition through the initiative of M. Vitte, Minister of Finance, and M. Markoff, Director of Excise, gave an idea of the organization and operation of the monopoly.

In all distilleries, there is installed an apparatus of control (Fig. 1), which measures the volume of the liquid and its degree. All the piping and all the joints are sealed with the State seal and every precaution is taken that nothing shall escape this meter. After its rectification, either in the works of the State or in those under its surveillance, the alcohol is analyzed with care, and particular watch is kept over the elimination of the amylic alcohol, aldehydes and other products called "alcohol of the last run," which constitute precisely the danger of unwatched manufactures and make of alcohol a true poison. After such tests have given a satisfactory result, the liquid is gaged and weighed with the greatest care and forced by pumps to the diluting tank, where it is mixed with the quantity of water necessary to obtain about forty-two degrees. This water is previously submitted to chemical analysis and filtered. The mixture in the diluting vat is made by means of an apparatus actuated by an electric motor. We then have brandy, which is forced into a vat, out of which it flows and passes first through a charcoal and afterward a sand filter (Fig. 2), and finally enters a reservoir in which it will remain until it is bottled. But previous to this, since the proof has been slightly lowered by the operation of filtering, it is brought to 40, the official degree at which it is delivered to the public.

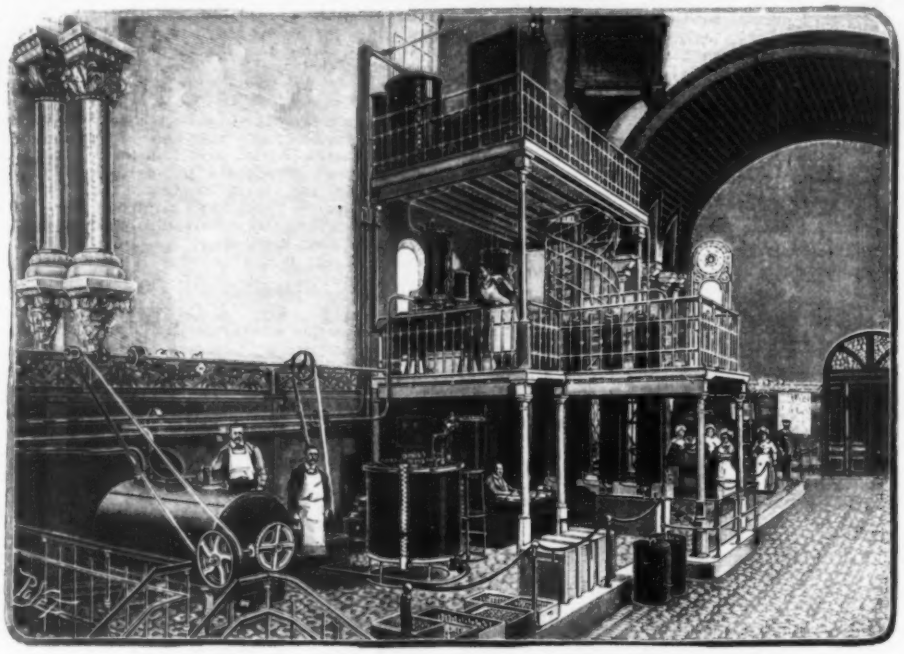


FIG. 2.—MIXING APPARATUS AND FILTERS.

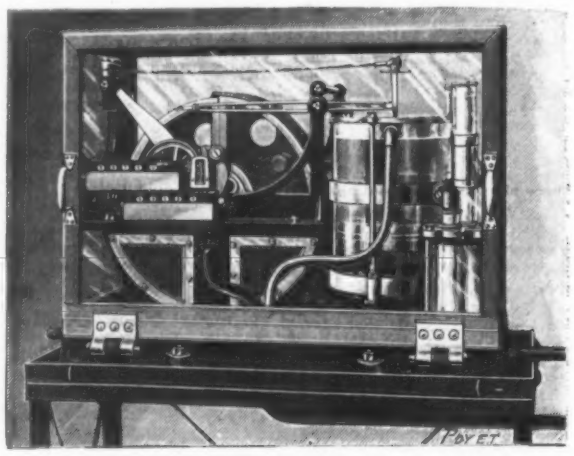


FIG. 1.—APPARATUS OF CONTROL PLACED IN DISTILLERIES.

The washing, rinsing, filling, corking and labeling of the bottles is done by very ingenious automatic apparatus (Fig. 3) into the details of which it would take too much space to enter, and which we can mention but briefly. Rotary brushes combined with jets of water, one of which is mixed with a jet of sand constitute the principal part of the cleaning apparatus. Upon making its exit from the last paper filter the brandy enters the gages, out of which it flows into the bottles. These latter then pass to the corking apparatus, in which each cork is surrounded with vegetable parchment and then dipped into melted wax. The important reform undertaken by the Russian government since 1894 is now extended over nearly the entire empire. Moscow will not be submitted to the new regime until next year, and Siberia not until two years hence. The authorities make no attempt to conceal the difficulties of the task, and admit that it is perfectible in many of its details; but in the presence of the good effects produced upon the material and moral state of the population, and the result so satisfactory from a fiscal viewpoint, we can but applaud this enterprise, which will be one of the greatest works of the reign of Nicolas II. for the welfare of the people.—For the above details and the accompanying engravings, we are indebted to La Nature.

DETECTION OF SUCROL IN FOODS AND BEVERAGES.

J. BELLIER (Annal. Chim. analyt.) finds a characteristic reaction of sucrol (dulcine) to be the formation of a turbidity or precipitate when a few drops of formaldehyde solution are added to a solution of the substance in strong sulphuric acid, and it is diluted with water. With less than 1 mg. of sucrol a distinct pre-

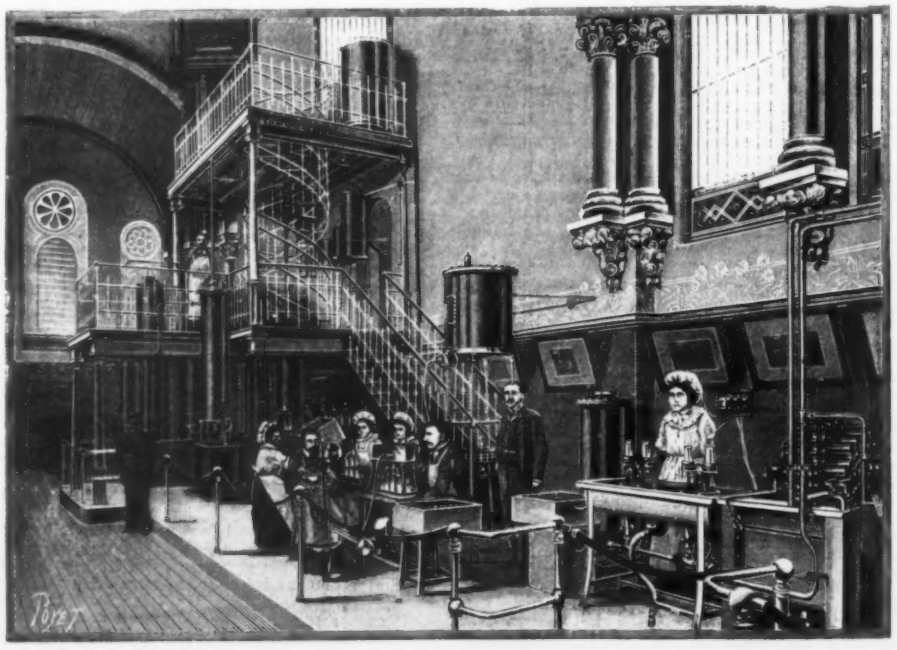
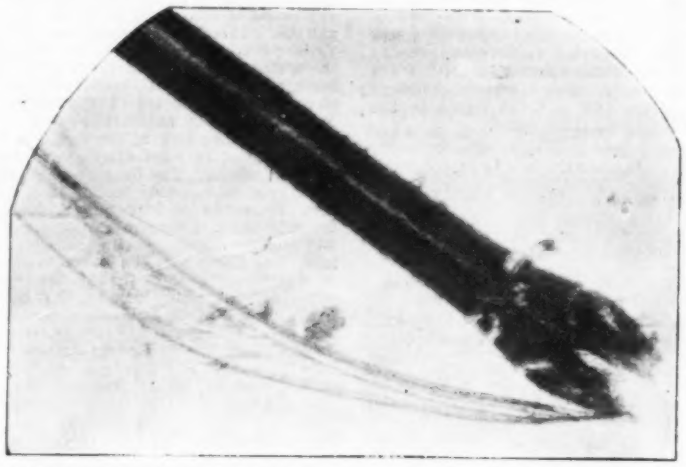


FIG. 3.—BOTTLING BRANDY.

cipitate is obtained on dissolving it in 1 c.c. of sulphuric acid, adding one drop of formaldehyde solution, and diluting with water to 5 c.c. The author finds shaking out with acetic ether from alkaline solutions to be the best method of extraction. Sirups, lemonade, waters, etc., may be treated thus directly. Fruit sirups, preserves, confectionery, and similar articles are rendered fit for extraction by dilution and precipitation with basic lead acetate. For quantitative determinations, any alcohol present in the original substance must be driven off by evaporation before treatment with the purifying precipitants; two extractions, each with 50 c.c. of acetic ether, are made. After extraction, the residue is dissolved in from 1 to 5 c.c. of concentrated sulphuric acid, a few drops of formaldehyde solution are added, allowed to stand for fifteen minutes, then diluted with water to ten times the volume. After standing for twenty-four hours the precipitate is collected on a tared filter, washed with distilled water, the filter and contents drained between filter paper, dried and weighed. Saccharin under like conditions gives no precipitate.



A MOSQUITO SUCKING BILL (A PROBOSCIS) AND DAGGERS; ALSO A FEW BLOOD CORPUSCLES. HIGHLY MAGNIFIED.

THE MOSQUITO AS TRANSMITTER OF MICRO-ORGANISMS.

By DR. R. MENGER, San Antonio, Texas.

As to the widespread mosquito family, scientists have accepted the theory that certain species of the genus anopheles (speckled wing-mosquito) are the transmitter and prime cause of malarial fevers, spores and plasmodia being transplanted by inoculation upon human beings, and producing the malarial fever paroxysms. As yet, though doubts are numerous as to the mosquito being the sole factor of malaria infection—climate, food and drink contamination (water and milk, etc.) or the inhalation of foul, bacteria-laden air in marshy, wet and tropical countries, etc., all of these influences undoubtedly bear their share in producing intoxication; and still if it be remembered how myriads of mosquitoes, of different type, abound and feed in foul water pool, sick-rooms, butcher pens, slaughter houses and hog pens, stables, sinks, sewer canals, privy vaults and marshy regions, where constant and lots of vegetable and bacterial decomposition is going on, if all of these facts are taken into consideration; also the comparative absence of the mosquito pest and malaria disease in salubrious and well drained and dry soils and climate; and, remembering the great inoculation facilities through the mosquito's stinging apparatus, then, indeed, it would seem without doubt that the mosquito insect is a great factor and contributor to malaria intoxication. What, though, is still lacking in connection herewith, are direct and positive proofs, and, it would seem, with our modern methods of clinical and bacteriological research, it should be an easy matter, especially in tropical countries, to disclose all doubts and speculations anent this important question; but as far as the rather meager literature at my disposal is concerned, the matter seems to be in a mere experimental state.

The mosquito always exists in malarial regions, as far as has been investigated. If patients suffering from malaria come into the region, then the mosquito becomes infected and spreads the disease. Whether the insect can acquire the parasite from any other source than man has not been settled as yet. It is not probable, however; so far as it is known, malaria has never been acquired primarily in uninhabited regions. Thus explorers, after passing through a country that would naturally be supposed to be malarious, seem to be immune until they reach the coast, where the mosquitoes are abundant, and the insects are able to obtain the parasites from those suffering from the disease.

An example of this is shown in Reunion Island, where there was no malaria until 1869. In that year a party of colonists came from India, and some of them suffered from malaria. The result was that the disease became very prevalent upon the island. The malaria spreader is the anopheles mosquito. It is a curious fact that they rest on a wall with their bodies at right angles to the surface, instead of flat against it, as is the case in the ordinary mosquito. The anopheles mosquito lays its eggs in stagnant water. If all the pools of stagnant water were removed, the pest would not breed.

As to our own country, it appears to me that the matter would be settled (in malarial districts) by direct and close examination; first, by examining bacteriologically samples of stagnating or foul water, on which the mosquito is supposed to feed; and, secondly, by close examination of the mosquito blood and secreta of the insects, especially particles adhering to the sucking bill and the dagger, etc. Also, it would be of great importance to ascertain if in certain instances and conditions the mosquito's blood harbors other pathogenic bacteria than the plasmodium; for instance, mosquitoes which had fed or sucked their body full with blood on persons afflicted with communicable diseases (scarlatina, yellow fever, typhoid fever, tuberculosis, etc.)

If a mosquito's anatomy be examined a little closer, the following presents itself: The roundish head, representing the prismatic eye-lens, is supplied at its front part with the proboscis, or sucking bill, antennæ and numerous hairy projections covered with scales. Its body shows a well developed capillary system and digestive canal, and, in the female, numerous delicate ovi-sacs containing the transparent oval eggs are seen, which, on cover-glass pressure, generally are evacuated. But the main point of interest to us is the mouth, or stinging parts of the mosquito. If a mosquito's head be mounted in glycerine and subjected to cover-glass pressure, a large amount of blood corpuscles and serum will be evacuated through the main cylindrical canal of the proboscis, and at the same time a bold, dagger-like protuberance will appear just below and in connection with the base of the mosquito's proboscis—the main "sting." Upon further pressure on the cover-glass a number of these sharp-pointed and slightly-curved daggers and lancets, resembling a curved hypodermic needle, will be dislodged. (Some of these daggers and the proboscis under high-power examination, can be seen on the microphoto plate.) These daggers seem to be under control of muscular action at the base of the proboscis, and the latter also shows, in connection with the base of the mosquito's proboscis, a delicate net-work of spiral shaped contractile tissue. The end part of this proboscis (the joint part seen on the micro-photo) shows several very delicate and oval-shaped hairy pads, which, during the scarification process of the daggers, are put into oscillating motion, and serve to accumulate and absorb the extravasated blood through suction when the blood is carried through the proboscis into a system of capillary canals traversing the mosquito's body. Such, at least, is my observation in a few instances. The proboscis, as well as the daggers, is very flexible, so that the mosquito can expand or retract the same.

THE GALILEO MUSEUM, FLORENCE.

THERE is no more picturesque figure in the whole history of science than Galileo Galilei, and everything that pertains to his life is most interesting. His life is so well known that it is unnecessary to do more than refer the reader to SCIENTIFIC AMERICAN SUPPLEMENT, No. 908. In the environs of Florence and commanding a superb view of the valley of the Arno is the Torre del Gallo, which is celebrated as having not only been the residence of Galileo, but also his observatory. The tower was restored in 1877. In the interior is a Galileo museum, containing portraits, books and manuscripts. Among the documents is one from the inquisitor of Florence relating to Galileo's sentence. The courtyard of the Torre del Gallo is also a fine specimen of medieval construction.

STERILIZATION OF DRINKING-WATER FOR ARMIES IN THE FIELD.

TYPHOID fever in every war has claimed more victims not only than wounds caused by weapons of destruction, but even than any other disease. The modern conditions of warfare, though far more sanitary than those of ancient times, do not appear to have exerted any very potent influence in decreasing the death roll from this malady. The report of the commission appointed to inquire into the various causes of death among our soldiers during the Spanish-American war has just been handed in, and from a perusal of this document the fact is gathered that enteric fever was responsible for the great majority of fatalities. The reasons assigned for this peculiar prevalence are many, but all are agreed that to the drinking of polluted water is due a large proportion of the typhoid-fever cases. The South African campaign is another prominent example of the wholesale devastation effected by this disease when it once gains a foothold among a large body of men. It is contended by some that this incidence and mortality are almost exclusively owing to the contamination of the drinking-water. What is needed is an effectual method of purifying the drinking-water. Filtration and boiling are the means which suggest themselves for sterilizing water. The Medical Magazine, November, commenting upon the subject, says: "Filtration must be done through the porcelain candle to be effective, but it is too tedious for practical uses in connection with great bodies of troops and for emergencies. Boiling is also inconvenient, and the cooling process entails waiting." The German government has caused a series of investigations to be made with respect to this matter, and some of the results have been given by Dr. MacWeeney (Journal of State Medicine, October, 1900). Tea and coffee were useless; brandy and wines were inefficient; formalin gives the water an objectionable taste and may injure digestion; permanganate of potassium was effective, but the drug was with difficulty got rid of afterward; alum, lime, ferric chloride, peroxide of hydrogen, iodine and chlorine were all tried and found practically unsuitable. Of all the substances to which a trial was given the author accords the preference to bromine. In a former number of The Journal of State Medicine the author described Schumburg's method of employing this element in the disinfection and sterilization of drinking-water. It may prove useful to recapitulate the conclusions at which he has arrived: (1) Free bromine added to drinking-water in the proportion of 0.0692 per liter (= 4.2 grains per gallon) kills all pathogenic germs, including those of typhoid and cholera, within five minutes. (2) In view of the difficulty of measuring bromine it is used dissolved in KBr solution according to the following prescription: Bromine, 21.91 gm.; potassium bromide, 20 gm.; distilled water, 100 gm. (3) The readiest way to estimate the free bromine in the solution is to add KI and starch paste and titrate the iodine set free with hyposulphate of sodium. (4) When the water is rich in ammonia or organic matter in solution, enough bromine must be added to produce a yellow coloration

GALILEO MUSEUM IN THE TORRE DEL GALLO, FLORENCE.

lasting for about half a minute. Visible impurities and coarse suspended matter must be removed by a rough process of sand filtration. (5) The bromine is to be got rid of when it has been acting for five minutes. For this purpose a nine-per-cent solution of ammonia was at first suggested, but the object is now accomplished by means of tablets of the following composition: Sodium sulphite, 0.095 gm.; sodium carbonate exsiccated, 0.049 gm.; mannite, q. s., one tablet to be used for a liter of water. In from one to two minutes all taste and smell of bromine have disappeared. Bromine is best conveyed in sealed glass tubes containing enough for 100 liters of water. With the overcoming of the difficulties in the way of purifying water effectively, in camps or on the march, the most important advance toward abolishing typhoid fever among soldiers will have been made. Some of the portable filters now in use are said to answer the purpose fairly well, but at the same time the best of them is far from perfect. Schumburg's method of employing bromine may clear the water of pathogenic germs, but it would seem to be too elaborate and intricate for use with soldiers on the march. If bromine possesses the qualities claimed for it, is it not possible to devise some more simple mode of utilizing them? There is a wide field for investigation here, and certain it is that to the man who discovers the means of purifying water by uncomplicated methods will come both fame and money.—Medical Record.

SELECTED FORMULÆ.

Theatrical Face Paints.—

WHITE.	Parts.
Prepared chalk	40
Zinc carbonate	40
Bismuth subnitrate	40
Asbestos	40
Expressed oil almonds	25
Camphor	1
Oil peppermint	5
Perfume	5

PINK.	Parts.
Zinc carbonate	250
Bismuth subnitrate	250
Asbestos	250
Expressed oil almonds	100
Camphor	55
Oil peppermint	55
Perfume	25
Eosin	1

DARK RED.

Like the preceding, but colored with solution of carmine.

BLACK.

1. Lampblack ..... 1 part
   Cacao butter ..... 6 parts
   Oil neroli ..... sufficient

Melt the cacao butter and the lampblack, and while cooling make an intimate mixture, adding the perfume toward the last.

2. Lampblack ..... 1 part
   Expressed oil almonds ..... 1 part
   Oil cocoanut ..... 1 part
   Perfume ..... sufficient

Beat the lampblack into a stiff paste with glycerin. Apply with a sponge; if necessary, mix a little water with it when using.

Horticultural Ink for Zinc Labels.—

Potass. chlorate	1 dram
Copper sulphate	2 drams
Aniline blue	5 grains
Acetic acid	2 drams
Distilled water	4 oz.

Dissolve the chlorate and sulphate in 3 ounces of water and the aniline blue in 1 ounce with the acetic acid. Mix the solutions.

Sirup of Cherries.—

Essence of cherries	4 oz.
Citric acid	3½ oz.
Cane sugar	6 lb.
Distilled water	10 pints
Liquid cochineal	sufficient

Dissolve the sugar in the water, and, when cold, add the other ingredients. The essence of cherries is made as follows:

Morella cherries	18 oz.
Blackheart cherries	18 oz.

Put them, whole, without stalks, but with the stone, into a wide mouthed jar and pour on 20 ounces of alcohol (90 per cent), cork up securely, and allow to macerate for eight months. Then decant the liquor and pour in 20 ounces of alcohol (40 per cent). After two months decant, press the fruit, mix the pressed liquor with the tincture from the two macerations, and dissolve in it one part of powdered sugar for each four parts by weight of the liquor. Allow to stand a few days, then filter.

Freezing Mixtures.—

I.

Potassium nitrate	2 lb.
Ammonium chloride	2 lb.
Water	5 pints

Mix.

II.

Potassium nitrate	2½ lb.
Ammonium chloride	2½ lb.
Sodium sulphate	4 lb.
Water	9 pints

Mix.

III.

Ammonia nitrate	4 lb.
Water	4 pints

Mix.

IV.

	Parts.
Sodium sulphate	8
Dilute hydrochloric acid	5

Mix.

V.

	Parts.
Snow	1
Water	1
Sulphuric acid	4

Mix.

VI.

	Parts.
Snow	3
Calcium chloride	4

Corn Plaster.—

	Parts.
Yellow wax	24
Venice turpentine	3
Resin	2
Salicylic acid	2
Balsam of Peru	2
Lanolin	4

Arnica Salve.—

	Ounces.
Solid extract of arnica	2
Resin ointment	16
Petrolatum	4
Sultanas	16
Fine-cut tobacco	1

Boil the raisins and the tobacco in 40 ounces of water until exhausted, express the liquid, and evaporate down to 8 ounces. Soften the arnica extract in a little hot water and mix in the liquid. Melt the resin ointment and petrolatum together, and add the liquid to the melted mass and incorporate thoroughly.

Dieterich's Hair Tonic.—

Quinine hydrochloride	1 dram
Tannin	2½ drams
Alcohol	27½ oz.
Tincture of cantharides	2½ drams
Glycerin	3 oz.
Cologne water	10 drams
Vaniline	1½ grains
Powdered sandalwood	¾ grain

Let the mixture stand for four or five days, and filter. The scalp is to be rubbed with the lotion every other day.

Medical Treatment for Toothache.—Dr. P. Ritter alludes (N. Y. Med. Jour.) to the fact that the physician is frequently called to see persons suffering from sudden affections of the teeth. For a periostitis he advises the careful cleansing of the cavity and the subsequent application of this anodyne mixture:

Morphine sulphate	3½ grains
Cinnamon water	2 drams
Peppermint water	15 grains

This to be applied to the painful tooth on cotton. If a pulpitis exists the pain may be relieved by painting the skin with the following solution every two hours and covering it with cotton:

Chloroform	2 drams
Balsam Peru	1½ oz.

For Constipation in Children.—The New York Medical Journal gives the following formula as a most effective remedy for constipation in children:

Powdered rhubarb	22½ grains
Powdered ipecacuanha	4 grains
Sodium bicarbonate	60 grains
Sirup	4 oz.

The dose is a teaspoonful every three hours.—American Druggist.

THE ETYMOLOGY OF JADE (THE MINERAL).

THE origin of this word remained a mystery until it was pointed out by Prof. Max Müller, in The Times of January 15, 1880, that it was the same word as Spanish *ijada* or *yjada* in *piedra de ijada*, a descriptive appellation given to it in the sixteenth century, in accordance with a belief long entertained that it possessed the virtue of curing pain or disease in the iliac region (*ijada*, late L. *iliata*). For the same reason Latin writers of the sixteenth and seventeenth centuries called it *lapis nephriticus*, and modern mineralogists *nephrite*. It has not, however, been yet shown how the Spanish *ijada* became *jade* in French and English, nor how the French *jade* is a noun masculine against Spanish *ijada* and Italian *iada*. This is, I suppose, one reason why French etymologists have not accepted Prof. Max Müller's identification, so that in the new "Dictionnaire Général" of Hatzfeld and Darmesteter, as in that of Littré, the derivation of *jade* still stands "origine inconnue." This link in the history of the word can now be supplied. Through the kindness of Dr. C. A. M. Fennell my attention was recently called to two passages in the English translation of 1657 of the "Letters of Voiture," in which "l'ejade" and "the ejade" are applied to a stone which the context indicated to be jade. On seeing these it was natural to infer that *l'ejade* must be simply taken over from the French original, and that probably the word would there be found to be, as it ought to be, feminine. On turing to the "Lettres de M. Voiture" both expectations have been verified. The word is *l'ejade*, and it is feminine. Mlle. Paulet had sent Voiture a jade stone with the hope that it might cure him of his malady, and in letter xxiii. (ed. 1665, p. 47) he says: "Ainsi pour ce coup, *l'Ejade* a eu pour vous vn effet que vous n'attendiez pas *d'elle*." In letter xlii. (p. 102) he says: "Je voy bien qu'il me faudra chercher des remedes plus solides que celuy de l'Ejade." These are rendered by Davies (ed. 1657, letter xxiv., p. 37), "So that for this time, *l'Ejade* hath had for you an effect which you expected not from it;" letter xlii., p. 79, "I perceive there must be found out for me some more substantial remedies than the Ejade (misprinted, by splitting the *d*, *Ejacle*)." The date of these letters is 1633. They show that *l'ejade* was already in vogue in France as a curative agent; but the word was new and strange, and its actual form uncertain, so that *l'ejade* feminine came to be ignorantly written *le jade* masculine, in which form it appears in the first quotation in the "Dictionnarie Général" in 1667. The anomalous masculine gender of the word in modern French is thus explained. *Le jade* is a bungled writing of *l'ejade*, and the bungle has not only decapitated the word, but changed its gender. In English we have no evidence that *ejade* ever passed beyond the pages of J. Davies's translation of Voiture. Our next quotations for the word are of 1727, also from French, and in the decapitated form *jade*. The quotations from Voiture's letters had not been supplied by any readers for the "New English Dictionary," and it is due to Dr. Fennell's clever "spotting" of them that this interesting link in the English—and still more in the French—etymology of the word has been supplied. There are no doubt many other cases in which the key to an etymological puzzle lies enshrined in a single passage.—J. A. H. Murray, in the Athenæum.

THE STORAGE OF WATER FOR IRRIGATION.

THE benefits to be derived from the construction of reservoirs for the storage of water for irrigation are strikingly brought out in Bulletin No. 92, Office of Experiment Stations, Irrigation Investigations, soon to be issued by the Department of Agriculture, entitled "The Reservoir System of the Cache la Poudre Valley." It was prepared by E. S. Nettleton, under the supervision of Elwood Mead, expert in charge of Irrigation Investigations. This bulletin describes the Cache la Poudre Valley; traces the history of its development; discusses the water supply and methods of irrigation practised; describes in detail the various storage reservoirs which have been constructed in the valley, and points out lessons taught by experience there.

"The average flow of the Cache la Poudre River for the month of July for fifteen years has been 840 cubic feet per second. The duty of water assumed in water-right contracts in this section is 80 acres to 1.44 cubic feet per second, or 55 acres per cubic foot per second. On this basis the average flow for July will irrigate 46,200 acres. The investigations of the duty of water, made last year under the direction of the Office of Experiment Stations, show that in the localities having the same general conditions as this valley, the average depth of water applied to the land irrigated is about 3.25 feet; that is, the water entering the head gates of the canal where measurements were made, would cover the area irrigated under these canals to that depth, provided it all reached the land. Assuming that the length of the irrigation season in the Cache la Poudre Valley is four months, and that the average flow of the river for July is the average for the four months, the natural flow of the stream would cover to that depth 62,945 acres. But the area actually irrigated by canals from this stream is at least 140,000 acres. The profitable cultivation of this area is made possible largely by the system of reservoirs and the exchange of water which has been developed in this valley. Ten years only have been required to build up the most complete system of storage in the United States. This has not been accomplished by a large expenditure of money, nor because of unusually favorable locations for reservoirs, nor was it wholly by accident that the people of this valley took up this line of irrigation development; conditions forced them into it. They did not wait for the general government or the State to build reservoirs for them, nor did they wait for the people of some other locality to demonstrate their practicability and financial success. While this system is by no means completed, the owners have already reaped much larger rewards for their labors than they expected, reaching into the millions of dollars.

"Although the necessity for storage reservoirs and their utility and benefits are generally recognized, but few people outside of Northern Colorado are aware of what has been accomplished in that locality by the utilization of small things or of the ingenuity displayed in making the most of them. There are other localities, not only in Colorado, but in nearly every one of the arid States, where the work of these people can be followed with beneficial results."

THE VALUE OF RESERVOIRS.

The report contains a table which gives the value of the crop due to the stored water in the Cache la Poudre Valley during the years 1897 to 1900, inclusive, as $3,063,083. Discussing this subject, the report says:

"The cost of the reservoirs has been given as $344,600. The figures in the table show, then, for the four years an annual profit of 222 per cent. This, however, is not a fair statement of the case. If there were no reservoirs the land would not have been planted to potatoes, and would probably have produced a good crop of grain or two crops of alfalfa, as these can almost always be matured with the natural flow of the river. What should be considered in estimating the value of reservoir water, is the difference betweén the value of the crops matured with stored water and the value of the crops which could have been raised without it. This, from the nature of the case, cannot be definitely estimated. The Yearbook of the United States Department of Agriculture for 1899 gave the average return per acre for potatoes in Colorado as $46.20, and the average for wheat $13.51. This would show an increased value of $32.69 per acre. The expense of harvesting potatoes is considerably greater than that for harvesting grain; so that this is not a net gain. But there is no question that potatoes are the more profitable crop; and there is no question among reservoir stockholders about this increase being sufficient to make the reservoirs a paying investment. However, exact figures in the matter are impossible.

"As has been stated before, the use of reservoirs makes sure of a third crop of alfalfa, which would be seldom obtained without them. No estimates have been made of the value of this third crop of alfalfa. This crop is not usually marketed, but is fed to sheep at home. It is estimated that about 500,000 head will be fed in the Cache la Poudre Valley during the season of 1900-1901. This means that 200,000 tons of alfalfa will be required, approximately the yield of 50,000 acres of land. Probably one-fourth to one-fifth of this alfalfa is raised with late water.

"But the value of these reservoirs to the agricultural interests of the valley cannot be measured by the money returns from the crops matured by the use of stored water. It has been shown that the use of the reservoirs has been greatly extended by the system of exchange. It has done away with the necessity of building long outlet canals for utilizing stored water, and has probably led to the improvement of sites which would still be unused but for this method of disposing of water. But it has had a far better result. It has

shown the farmers and canal companies the fallacy of the cutthroat policy which they have followed for years, and has begotten a spirit of co-operation which, if carried over into the management of their canals, will increase the efficiency of their water supply far more than has been done thus far by the storage of water which ran to waste during the winter and flood period. To do this would require a partial waiving of the rights to divert the quantity of water decreed them under any and all conditions heretofore asserted by most appropriators. This would result in injury to no one if properly carried out; on the other hand, it would be a benefit to a large majority of the water users in the valley. Experience has proved that rotating in the use of water from canals results in a great saving, both of time and of water. Every practical irrigator realizes the advantage of having a large head of water for a short time rather than a small head for a long time. Much more can be accomplished with ten cubic feet per second for one day than one cubic foot per second for ten days. No sane man would undertake to irrigate his 106-acre farm all at one time when he has only water enough to flow over ten acres. He would 'bunch' his water instead of scattering it all over his farm through so many channels that more than half the water would be absorbed in wetting up the ditches. If the distribution of water in the river and in the canals in the times of scarcity was managed with the same economy as is practised by the individual irrigator, it would add millions to the value of the products of the valley."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Russian Importation and Production of Coal.—Consul-General Holloway reports from St. Petersburg, January 4, 1901:

The Rusisan Minister of Finance has announced that foreign coal imported for government railroads will be admitted free of duty at all Russian ports until July 14, 1901, by which time, it is expected, the domestic supply will equal the requirements. In consequence of strikes in coal mines near Warsaw and Lodz, coal intended for use in those cities is admitted free, and a material reduction has been made in the duty on coal for use in Odessa, Sebastopol, and Nikolaeff. The output of coal in Russia in 1897 was 10,900,000 tons; in 1898, 11,956,000 tons. The figures for 1899 are not completed; but the output for the first six months of that year indicated an increase of 7,000,000 tons over the production for the same period in 1898, and it is expected that the last part of the year will make a still better showing.

American Advertisements in Germany.—In compliance with special instructions from the Department of State I have to report, says Consul-General Frank H. Mason, of Berlin, in respect to the restrictions imposed by certain trade journals in Germany upon the publication of advertisements of American products, as follows:

This movement dates from the year 1896 and was at first directed against American bicycles, bicycle parts and materials, which in that year began to seriously invade the German market. The league of German bicycle manufacturers held several meetings, at which the growing competition of American wheels was earnestly discussed and an organized and determined effort made to secure from the imperial government a decree increasing by several hundred per cent the nominal duty on imported bicycles. It will be remembered that when the present German tariff was enacted, bicycles were not an important article of international traffic, and they were not therefore specifically named in the schedule, but have since been classified as "vehicles" at a rate which makes the duty on an American wheel (weighing from 20 to 30 pounds) from 5 to 7 marks ($1.19 to $1.67) only, a rate which naturally imposes no serious obstacle to importations.

Failing to secure any advance in the rate of duty, the Association of German Manufacturers adopted the plan of boycotting, so far as possible, advertisements of American wheels and bicycle parts in the trade publications of this country. There were at that time half a dozen or more papers devoted almost wholly to the bicycle trade, and these were given to understand that they must choose between the patronage of the German bicycle makers and their foreign competitors, especially those of American nationality.

Under this pressure, most if not all the German bicycle publications refused to accept American advertisements, and this restriction is still maintained by the Radwelt (Berlin), the Radmarkt (Bielefeld), and the Deutsche Radfahrerzeitung (published at Essen, none of which, so far as can be ascertained, now accept advertisements of American bicycles or materials.

Several leading German bicycle makers are also manufacturers of sewing machines, and an effort was made to likewise exclude advertisements of American sewing machines from German newspapers, including even the daily press. This movement, however, failed—at least so far as the daily newspapers were concerned. They refused to be bound by any such narrow policy and freely accept advertisements of American products on the same terms as those of native origin. Some of the trade publications which are dependent upon the patronage of the home trade have been compelled to exclude advertisements of American machines, though to what extent this form of boycott has been developed it proves difficult to ascertain.

It will be understood that publications which have been dominated by this movement are of relatively small importance. At the outset the American bicycle companies which sought to reach this market were undoubtedly delayed and to some extent injured by the exclusion of their advertisements from the trade papers; but they expended their money in sumptuous circulars, catalogues, posters, and other special forms of advertising, which, as they now think, were more effective and attained the desired result.

The manager of a leading American bicycle company which has its wholesale depot at Hamburg and has built up since 1895 a large and permanent trade writes, in reply to a special inquiry on this subject:

"We have paid no attention to the cycle papers during the past four years. Five years ago we advertised in the Radwelt and the Radfahrerbundes Zeitung, and at the end of 1896 they refused to take further advertisements from us. We therefore spend the same money on illustrated papers published in Germany and, we think, to much better advantage. In fact, if all those papers should now offer to take our advertisements, I do not think we would accept their offers. A few years ago, this undoubtedly hurt us; but under present conditions of the bicycle business, the trade paper does not have the same influence that it formerly had."

This would appear to describe the present situation correctly in so far as the bicycle trade is concerned.

Meeting of Iron Manufacturers of Russia.—Consul Smith writes from Moscow, December 21, 1900:

The Ministry of Agriculture has found it necessary to call a meeting of the iron manufacturers of the country, to consider the present crisis in the iron industry of Russia, as the majority of puddling furnaces and rolling mills are at a standstill. This serious state of affairs has attracted the attention of the government, which will take energetic steps to uphold the iron manufacture of the country. Large quantities of iron ore have been exported lately to England.

Spanish South American Steamship Service.—Writing from Montevideo, under date of December 3, 1900, Consul Swalm says that the Spanish Pacific Line has given notice of the abandonment of the service to the west coast of South America, the traffic proving unremunerative. These steamers are of an excellent class, but conditions seemed to favor the older English and German lines. The last Spanish steamers called no farther south than Montevideo.

Rubber from the Hule Plant in Mexico.—A process for extracting rubber from the hule plant was discovered about a year ago by a Mexican doctor residing in Sierra Mojado. This plant, which contains about 40 per cent of rubber, grows in the mountainous districts of Mexico, as well as in certain localities of Texas, Wyoming, and Nebraska. It is a species of sage brush, with small leaves, and grows to a height of about 3 feet.

A patent on the process has been taken out in the United States and Mexico and a manufacturing plant has been located at San Luis Potosi. All the machinery for use in extracting the rubber has been invented and patented in both countries by the Monterey Foundry and Manufacturing Company, of Monterey.

The principal steps in the process of manufacture are as follows: There are special machines which feed the plant automatically into the cutters; after it comes out of these machines, it is carried by a bucket elevator and dumped into steam-jacketed mixing tanks, containing certain chemicals; the product then runs by gravity into hydraulic filter presses, after which it is subjected to a hydrostatic pressure of 75 pounds to the square inch; it is then conveyed into settling tanks, where the gum, being heavier, settles to the bottom, while the chemicals and residue are drawn off.

The cost of production is slight. The principal difficulty to be overcome is the high freight rate, a box car being quickly filled on account of the lightness and bulkiness of the plant.—P. Merrill Griffith, Consul at Matamoros.

The Vintage of 1900 in Germany.—The labors of the German wine growers have once more come to an end; that is, as far as gathering the grapes is concerned. For the wine grower, the time from early spring until the grapes are gathered in the fall is one of constant trepidation. No other crop is so uncertain or gives rise to such anxiety. A single sharp frost or a long-continued rain may suffice to ruin the vintage.

Last May, after the vines had begun to put forth their tender shoots, a severe and unexpected frost caused irreparable damage in many vineyards. After the vines had flowered the weather still remained unsettled; and the prospects were not bright. The summer and early fall months, however, were so exceptionally fine that those grapes which had escaped the frosts in May rapidly ripened to a magnificently mellow fruit.

On the whole, the grapes were quite free from disease during the period of growth. The "Sauerwurm" was their chief enemy this year, and in some districts—as, for instance, the Rheingau—did considerable damage. In the Moselle districts, the early frosts caused the chief damage and reduced the vintage to about one-fourth or one-half of a full one.

On the whole, however, the wine growers may well be satisfied with this year's vintage, both as to quantity and quality. About half of a full crop has been harvested, and the quality promises to be a good "middle wine," ranging between the vintages of 1895 and 1897.

So much for the situation in general. As regards the various wine-growing districts, the following is a synopsis of the results in each:

In Rhenish-Hesse, more than half of a full crop was harvested. The sales in small wines were very brisk; middle and better grades, however, being held for better prices. The must gaged on the average 70 degrees, according to the Oechsle system, with an acidity of 7 per 1,000. The average price for must was 450 marks per 1,200 liters ($107.10 per 320 gallons). Higher prices, however, are by no means rare. Sales at 1,200 marks per 1,200 liters ($285.60 per 320 gallons) for the best grades give an idea how prices will run.

The Rheingau, which yields the finest Rhine wines, will only yield about one-third of a full vintage. The must gages from 85 degrees to 90 degrees; that of specially-selected grapes, however, far over 100 degrees. The average price is now 1,200 marks per 1,200 liters ($285.60 per 320 gallons).

On the Middle Rhine the quantity is satisfactory, and the prices average 575 marks per 1,200 liters ($136.85 per 320 gallons).

The vintage on the Nahe River was completed by the end of October. The quantity was larger than expected. The quality varied considerably. The must gaged from 65 degrees to 90 degrees and even exceeded 100 degrees in the best districts. Prices ranged from 14 to 32 marks per 40 liters ($3.33 to $7.62 per 10½ gallons), according to quality.

The vineyards of the Moselle River yielded only a scant one-fourth of a full vintage. The must gages 80 degrees to 85 degrees, with an acidity of from 8 to 9 per 1,000. The prices demanded by these wine growers are simply exorbitant—higher than they have ever been—and do not appear to be warranted, considering the quality. In the neighborhood of Trier, from 900 to 1,500 marks per 1,000 liters ($214.20 to $357 per 266 2-3 gallons) is being paid. On the Upper Moselle the price is 500 marks per 1,000 liters ($119 per 266 2-3 gallons) and on the Lower Moselle 750 to 1,000 marks per 960 liters ($178.50 to $238 per 256 gallons) is being paid for Riesling.

On the River Ruhr, a tributary of the Moselle, the result of the vintage is one-fourth to one-half of a full crop. The must gages 80 degrees to 95 degrees. The prices for must range from 1,600 to 2,000 marks per 1,000 liters ($380.80 to $476 per 266 2-3 gallons); these prices have never before been reached.

On the Saar River the conditions were similar, and prices ranged from 1,600 to 2,000 marks per 1,000 liters ($380.80 to $476 per 266 2-3 gallons).

In the Haardt Hills the gathering of the crop was completed by the middle of October. The quantity was greater than expected, and the prices, which were at first too high, have weakened, and consequently buying is brisk.

Alsace-Lorraine has had an exceedingly good vintage. However, there are still many wine growers who do not give rational treatment to their vineyards, and consequently their vintage is small and inferior.

Baden has also had a very satisfactory vintage. Both quality and quantity came up to expectations, and trading has been very brisk.

In Württemberg the quantity harvested was larger than expected, because the grapes were exceedingly juicy; and as the prices offered were acceptable, trading was very brisk.

In the vineyards of Franconia that were well cultivated, the result of the vintage was satisfactory.—Walter Schumann, Consul at Mayence.

Remedy Against Mosquitoes.—A simple remedy against mosquitoes has been employed in several places in South America and is equally well adapted to the temperate zone. It consists in planting the castor-oil plant (Ricinus communis), or "palma christi," around the house and premises.

In cold and temperate climates the castor-oil plant grows to a height of 4 or 5 feet; in these countries it becomes a tall tree and is perennial. It seems that the smell of the plant is disagreeable to mosquitoes and other insects, and it is an acknowledged fact that where these plants grow few mosquitoes will be found.

My personal experience bears this out, says E. H. Plumacher, Consul at Maracaibo. My residence is surrounded by plantain and banana trees, and I have been much troubled in the past by the great number of mosquitoes which gathered between the leaves. Following the example of old settlers in the country, I planted the castor seeds, which grew up in profusion, and there are now no mosquitoes to be found among the plantain and banana trees, although I keep the ground well irrigated. By keeping branches and the seeds of the plant in rooms the mosquitoes are driven away from the latter.

There are several varieties of the castor-oil plant. In this country there are two—one with brown nuts and the other white in color, with a kernel tasting like the fresh almond.

Wheat Crop of Argentina and Uruguay.—Consul Swalm, of Montevideo, informs the Department, December 7, 1900, that the wheat crop in the River Plata provinces of both Argentina and Uruguay is reported as being in a very bad condition. The young plants have been damaged by an exceedingly heavy rainfall, the soil being thoroughly saturated for weeks. An unusually hot spell, following cold weather, has also induced a blight that will leave many fields unprofitable. On the Argentine side, in numerous instances, a yield of not over 8 quintals (13.5 bushels) to the hectare (2.471 acres) is expected, while in Uruguay, it is doubtful whether there will be sufficient wheat raised for home consumption alone. Generally there is very little doubt but that the River Plata exports of wheat will fall at least 50 per cent below those of last year, and the same is true of linseed.

South American Steamship Service.—Consul Jenkins reports from San Salvador, December 10, 1900:

The Pacific Steam Navigation Company and Sud Americana Vapores have advertised that, in accordance with arrangements made with the Panama Railroad Company, they will make weekly trips to all Central American ports and take freight consigned via the Isthmus to the United States and Europe; further, that a semi-monthly service to San Francisco will be inaugurated by the steamer leaving Valparaiso on December 26.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 952. February 4.—Vancouver-Alaska Direct Steam Communication—Argentine Wheat and Linseed Crops—Shingle Combine in British Columbia—New Process for the Preparation of Leather—*American Steel Rails in Australasia.

No. 953. February 5.—Council of Labor in Marseilles—Flax in Europe—*Development of Samoa—Brazilian Rubber Shipments.

No. 954. February 6.—Importation of Coffee into France—*American Furniture in England—*New Railway in British Columbia—*Reopening of Ports in Colombia.

No. 955. February 7.—*British Industrial Depression—*Belgian Demand for Poultry-Plucking Machines.

No. 956. February 8.—Forestry in India and Canada—Placer Gold Mining Claims in British Columbia—The Baltic-White Sea Canal—Rebate in Guatemalan Tariff.

No. 957. February 9.—Development of the Canadian Northwest Territories—Automobile Regulations in Amsterdam—Wreck on the Yangtze Kiang.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Examination of Glycerine.—Calixte Ferrier employs the following method for testing glycerine, especially for the estimation of the ash percentage of the commercial article: Ten grammes of glycerine is evaporated in a platinum dish, avoiding as much as possible all spattering. The tarry residuum is burnt and after the spongy mass which remains behind has been broken up, 5 or 6 c. cm. of distilled water is poured into the dish; digest for a moment and draw off the clear solution by means of a pipette drawn out into a capillary tube. Next wash for a second time with the same quantity of water and preserve the solution obtained (10 to 12 c. cm.). The contents of the dish are dried and calcined at such a temperature as is required for burning the coal, which takes only a short time. Cool off, return the wash waters to the calcined residue and evaporate carefully as usual, dry thoroughly and heat one or two seconds to red heat. Thus the melting or the simultaneous evaporation of the carbon is prevented, and by this method constant results, correct almost to 0.0001, are obtained.—Chemiker Zeitung.

Oxidized Steel.—The popularity of articles of oxidized steel in conjunction with gold, filled gold and silver gilt, with genuine and imitation stones, as brooches, bracelets, match boxes, cigarette cases, handles and knobs for umbrellas and canes, watches, etc., is well known. Less well known are good receipts for oxidizing the steel, which it is necessary to be acquainted with at the present time, since the less agreeable side of these articles, viz., the wearing off of the oxide, makes itself felt more and more and a reoxidizing of the objects is frequently required.

Therefore, we will give some recipes to cover this field:

1. Oxidizing of Steel.—Mix well together bismuth chloride 1 part, quicksilver bichloride 2 parts, copper chloride 1 part, hydrochloric acid 6 parts, alcohol 5 parts, and water 5 parts. To use this mixture successfully the articles to be oxidized must be cleaned perfectly and freed from all grease, which is best accomplished by boiling them in a soda solution or by washing in spirit of wine. Care should be taken not to touch the article with the fingers again after this cleaning. However clean the hand may be, it always has grease on it and leaves spots after touching, especially on steel. Next the object is dipped into the liquid, or if this is not possible the solution is applied thin but evenly with a brush, pencil or rabbit's foot. When the liquid has dried on the article the latter is placed for a half-hour in simple boiling water. If a very dark shade is desired the process is repeated until the required color is attained.

Another Process.—Apply, by means of a sponge, a solution of crystallized iron chloride 2 parts, solid butter of antimony 2 parts and gallic acid 1 part in 5 parts of water. Dry the article in the air and repeat the treatment until the desired shade is reached. Finally rinse with water, dry and rub with linseed oil varnish.

Process Especially Suited for Steel Watch Cases.—The case to be oxidized is thinly coated with diluted sulphuric acid or hydrochloric acid or a solution of green vitriol, to which a little nitric acid is added to hasten the action to cause the formation of rust. After about 24 hours remove the resultant coatings as far as possible with a steel wire brush, and repeat this operation several times. Next, the article is dipped into linseed oil or oil of turpentine; this is allowed to trickle off, and the article is heated almost to a red heat. After slowly cooling, rub the case neatly and evenly with turpentine oil or linseed oil, using a linen rag.

Another Process for Steel Watch Cases.—After the case has been neatly polished off with used fine emery cloth and cleaned of all traces of fat, it is stuck with the bow knot on an iron wire about 25 cm. in length which has been filed into a conical point. This wire serves as a handle for the manipulations, which can now be conducted without having to touch the case itself. Now heat the case lightly over an alcohol flame, coat it with ordinary white wax and let cool. Next wipe the wax off again neatly inside and outside with a soft cloth, using a little piece of wood where the cloth has no access. It is essential that no wax remains adhering to the case, for in the subsequent heating any wax would render the case or rather the oxidization greasy. Now take a small handful of cotton wool or wadding, lay it into a little tin box, pour ordinary oil of turpentine or benzine over it and light it. This work has to be carried out in a place free from draught on account of the danger of explosion. While the cotton is burning hold the case for a minute in the flame, so that it becomes evenly and thickly covered with soot. After the cooling wipe the case off again with a soft rag. This process is repeated until the shade has been attained. Naturally the polishing off with emery becomes unnecessary in repeating the work. For a first trial take a small lady's watch, so as to obtain the necessary practice for larger surfaces.

Another Process.—In order to remove all grease from the steel parts, which is indispensable for the production of a faultless oxide, boil the articles in soda or caustic soda lye or wash them at least in spirit of wine. Next heat the object to 100 deg. C., either in the oven or, better still, by dipping the pieces for a few minutes in strongly boiling water until they have acquired the temperature of the water. In a clean earthen vessel right near the boiling water have a solution ready consisting of 10 parts of water and 1 part of potassium bicarbonate. The articles are now quickly plunged into the prepared solution, being well moved about so that the solution can act upon all parts. Next dry the objects in the air and hold them for about 2 minutes over an open, lively glowing, but not sooting coal fire. This treatment is repeated once or twice according to the desired color. With some practice with regard to the right temperature and the duration of the immersion in the liquid, the well-known brown-black coating of metallic luster is obtained. By increasing the temperature the deep black shade without metallic shimmer is produced.—Deutsche Goldschmiede Zeitung.

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